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ECONOMIC ANALYSIS OF EFFLUENT GUIDELINES
GRAIN PROCESSING SEGMENT OF THE GRAIN MILLS INDUSTRY

DEVELOPMENT PLANNING AND RESEARCH ASSOCIATES, INC.

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

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The economic impacts of proposed effluent limitation guidelines on four subindustries of the grain milling industry are assessed: corn wet milling, corn dry milling, rice milling and bulgur (wheat) processing. The analysis includes classification and description of types of firms and plants, financial profiles of selected model plants, and prices and pricing practices within each subindustry studied. The financial impacts of water pollution control costs on model plants were assessed using discounted cash flow analysis and industry-wide impacts were projected.

Grain milling wastewaters are generally amenable to biological treatment systems. Consequently, many milling plants can and have tied into municipal treatment systems. All rice mills (parboiled only), bulgur processors and most corn dry mills discharge into municipal systems. Industry-wide impacts should therefore be minimal.

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Samuel G. Unger
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February, 1975

Prepared for
Office of Planning and Evaluation
Environmental Protection Agency
Washington, D. C. 20460

PREFACE

The attached document is a contractor's study prepared with the supervision and review of the Office of Planning and Evaluation of the U. S. Environmental Protection Agency (EPA). Its purpose is to provide a basis for evaluating the potential economic impact of effluent limitations guidelines and standards of performance established by EPA pursuant to sections 304(b) and 306 of the Federal Water Pollution Control Act.

The study supplements an EPA technical "Development Document" issued in conjunction with the promulgation of guidelines and standards for point sources within this industry category. The Development Document surveys existing and potential waste treatment and control methods and technologies within this category and presents the investment and operating costs associated with various control technologies. This study supplements that analysis by estimating the broader economic effects (including product price increases, continued viability of effected plants, industry growth and foreign trade) of the required application of certain of these control technologies.

This study has been submitted in fulfillment of Contract No. 68-01-1533, Task No. 2 by Development Planning and Research Associates, Inc. Work was completed as of February, 1975. The study is based primarily upon an earlier study, also prepared by Development Planning and Research Associates, Inc. entitled "Economic Analysis of Proposed Effluent Guidelines, Grain Milling Industry."

The earlier report was circulated in conjunction with the publication in the Federal Register of a notice of proposed rulemaking under sections 304(b) and 306 for the subject point source category. The analysis contained in the original study has been revised based upon information received during the period of time between publication of the notice of proposed rulemaking and the promulgation of the final regulation. Because of the constraints of time, the control and treatment costs analyzed in this study may not in all instances be identical to those associated with the requirements of the promulgated regulation. However, those differences, when they exist, are minor insofar as the final conclusions of the study are concerned.

This report represents the conclusions of the contractors. It has been reviewed by the Office of Planning and Evaluation and approved for publication. Approval does not signify that the contents necessarily reflect the views of the Environmental Protection Agency. The study has been considered, together with the Development Document, information received in the form of public comments on the proposed regulation, and other materials in the establishment of final effluent limitations guidelines and standards of performance.

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ECONOMIC ANALYSIS OF EFFLUENT GUIDELINES GRAIN PROCESSING SEGMENT OF THE GRAIN MILLS INDUSTRY

EXECUTIVE SUMMARY

This report investigates the economic impact of the Environmental Protection Agency's effluent guidelines on specific segments of the Grain Milling Industry:

SIC 2041	Flour and Other Grain Mill Products (Flour only)
SIC 2044	Rice Milling
SIC 2046	Wet Corn Milling

I. INTRODUCTION

Producing a multiple product mix, these three industry's accounted for 20.4 percent of the establishments and 37.4 percent of the employees of the total grain mills products sector (SIC 204) in 1967. Their products and the processes characteristic to their production are diverse enough to require differing considerations in this report; consequently, the report examines each industry separately in determining the economic impact each would realize under EPA's proposed effluent control guidelines.

The three industries have shown a decline in the number of their plants and companies in recent years as was reported for the period 1963-1967 by the Census of Manufactures.

Industry		Plant Numbers		Company Numbers	
		1963	1967	1963	1967
SIC 2041	Flour and Other Grain Mill Products	618	541	510	438
SIC 2044	Rice Milling	74	68	62	54
SIC 2046	Wet Corn Milling	60	45	49	32

II. SIC 2041: FLOUR AND OTHER GRAIN MILL PRODUCTS

Establishments in SIC 2041 are subdivided on the basis of their primary products into four subindustries:

SIC 20411	Wheat flour, except flour mixes
SIC 20413	Corn mill products
SIC 20415	Flour mixes, refrigerated doughs made in flour mills
SIC 20416	Other grain mill products

The largest SIC 20411, represents approximately 75 percent of the total industry's shipments.

Discussions with industry spokesmen and an examination of industry data indicated that only two divisions of SIC 2041 involve water pollution problems associated with milling, per se, extensive enough to justify their examination in this report: (1) Bulgur (wheat) processors who use washwater and/or "steepwater" drainage in their production and (2) only corn millers who employ washwater.

Data from the industry justify, therefore, this study's correlation in SIC 2041 upon (1) bulgur processing and (2) dry corn milling which requires approximately 5 to 7 gallons of washwater for each bushel processed for human consumption.

Bulgur Industry Segments

Types of Firms and Plants

Commerical production of bulgur wheat began in the United States in the mid-1950's. Although domestic production was initially typical, export sales, especially under trade programs such as the USDA's relief programs and Title I of PL 480, now dominate production.

Only six milling firms (out of a once seventeen) are actively engaged in commercial bulgur wheat production. These six mills are but a small segment of each parent company's overall milling operations. . Three of the parent companies, for instance, are among the leading twenty flour millers in the country.

The plants, located in Western and Mid-western states have capacities ranging from 2,500 cwt. to 9,000 cwt. per day and average approximately 5,000 cwt. per day. The composite annual production of the mills in 1971 and 1972 totaled about 5 million hundredweight to indicate a production utilization of capacity at one-half of potential yearly capacity (330 days, 24 hours per day).

Bulgur production employs relatively modern technological processes of four distinct types: (1) Albany process, (2) Robbins process, (3) second generation Robbins, and (4) third generation Robbins. The three Robbins processes vaporize all wastewater and only the Albany process has wastewater drainage.

Employment and Production Distribution

If the six plants were grouped by size based upon employment into three categories, their ranges and percentage of industry employment and production would be as follows:

Plant Range	Workers Required per Plant	No. of Plants	Total Employment	Percent of Industry Employment	Percent of Industry Production
Small	20-25	2	40- 50	23	19
Medium	30-35	2	60- 70	33	31
Large	40-45	2	80- 90	44	50
TOTAL		6	180-210	100	100

Likely Impacted Segments

All plants would be substantially affected by the increased costs of pollution control facilities if they were required; however, as indicated above, plants which employ Robbins processes have no consequential wastes. Such plants may be eliminated from further study consideration.

Overall study data of the types of processes used in bulgur milling plants indicate that bulgur plants do not have significant pollution control problems.

Bulgur Financial Profile

Plants by Segment

Little specific data exists on the bulgur processing industry; the study, therefore, based its conclusions upon an engineering synthesis of data for a model of a "medium" size operation to approximate industry averages.

The medium-sized model had a production of 5,000 cwt per day. Since a characteristic of the industry is its underutilization of capacity, the model plant's production was estimated as: 5,000 cwt. per day with an annual capacity of about 1.65 million cwt. (7,920 production hours) and a throughput volume of 0.832 million cwt. (4,000 production hours).

Bulgur processing plants have apparently not maintained high profit return levels because of limited bulgur demand and the industry's consequent underutilization of capacity. The industry's rate of return on investment is estimated at 7 percent, and its after tax earnings on sales are a relatively low 1.7 percent. The annual cashflow (after tax income plus depreciation) for bulgur processing is nominal for grain milling firms. The industry's market (salvage) value of assets is low beacuse of its underutilization of capacity; consequently, the value is related primarily to its dismantled values based upon the machines being used by other milling segments.

Capital Structure

Similar to other agricultural processing industries, bulgur processing's capital structure generally requires low investments per dollar of sales ($1.00 yields $4.22 in sales) on a model plant estimate. The data also indicate that though the industry is not especially capital intensive, it does require substantial working capital.

Cost Structure

Model plant data indicate that a medium-sized plant has indirect operating costs representing only 3 percent of sales and direct operating costs of approximately 12.1 percent of sales.

Ability to Finance New Investments

In the absence of dependable data for the bulgur industry, the estimates or a model plant's ability to generate new investments were based upon accepted economic procedures. Applying such procedures to the grain milling industry, as a whole, the processing industry is characteristically below average in profitability, both as a percentage of sales and of net worth compared to other industries. An examination of the milling industry's data for debt, both long term and current, its cash flow conditions, and its profit margins indicates an instability in the industry which makes it one relatively unattractive for equity capital and one which requires lower debt/equity ratios than does manufacturing in general. Even so, milling can apparently attract sufficient capital to finance new investment. The conditions governing the bulgur industry's ability to generate new capital funding are affected also by that fact that all plants are but part of larger milling concerns.

Bulgur Pricing

Demand and supply relationships determine bulgur prices and are greatly determined by the fact that the U.S.D.A. purchases 99 percent of production through low bid contracts. The government's purchases are nearly all (99 percent of purchases) exported under foreign aid programs. The exports go essentially to Southeast Asia (80 percent) and to other Asian countries, the Middle East and Africa.

Its acceptance as a high-protein, high-quality food in developing countries is lately being enhanced by producers who are now further supplementing its protein content by adding 15 percent of bulk in soy grits to form "soy fortified bulgur." Total sales of bulgur grew slowly to a 5 million hundredweight in 1972. The total U.S. production is equivalent to about one-half of one percent of the nation's annual wheat production.

Bulgur demand approximates production. Less than one percent is distributed through commercial channels and only a minor 1 percent of government purchases are used in domestic food programs. So government demand for 'soy fortifies bulgur' increases, firms have added appropriate production facilities.

The prices of bulgur products are not affected by commercial markets and are determined by competitive bidding. Because such bidding is on the basis of exporting port prices, the availability of wheat and a plant's location results in comparative pricing advantages for specific plants when they bid for specific location-dependent contracts.

Bulgur prices vary directly and proportionally with wheat and now, though to a lesser extent, with soybean prices.

The price of bulgur is further affected by its being price elastic (elasticity less than -1.0) and demand will be affected where local currency sales are made; thus, demand decreases substantially with small price increases. Inefficient plants suffer correspondingly. Small plants suffer, also, as the per unit cost of bulgur rises in response to pollution control costs. The rise in costs, reflected in prices, results in substantially lowered production.

Corn Dry Milling Industry Segments

This segment manufactures corn meal for human and animal consumption. Among its products are whole corn meal, degermed corn meal, corn grits, and hominy, and many are used in the brewing, breakfast food and snack industries.

In 1971, 116 firms operated 124 corn dry mills. Data indicate that twenty-eight mills, apparently small, marginal ones, closed between 1965 and 1971 ant that other mills had expanded capacity. Most plants are located in the Southeastern states. Their listed capacities range from 25 to 20,000 cwt per day of meal production.

All but one corn dry mill uses the tempering-degerming process for producing degermed products, and about 80 percent of the corn dry milled for corn meal, flour, grits, and breakfast foods is degermed.

In 1972, the industry used 139 million bushels of corn, about 3 percent of the nation's domestic corn consumption, a rate that does not substantially affect corn prices.

Data indicated that only corn dry mills using the tempering-degerminating processes are likely to be significantly impacted by water pollution control requirements. These mills tend to be relatively large, are mostly located in the Mid-West, and produce a high percent age of the total corn dry mill products in the United States.

Corn Dry Milling Financial Profile

Because dry corn milling data was unavailable, the study constructed an appropriate model plant of a moderately large, tempering-degerminating plant of 12,000 cwt per day capacity. The plant was assumed to operate at 100 percent of capacity defined as 6,240 production hours per year. The model represents the industry's general conditions.

The after-tax ROI was estimated at 8.8 percent and after-tax earnings on sales were 2.6 percent. Model plant data also included estimates for annual cash flow which showed the industry to be comparable to other milling industry ratios. A salvage value of 50 percent estimated replacement value was also used.

Capital structures were also estimated and indicated that the corn dry milling industry is similar to other agricultural processing industries which require a low investment per dollar of sales. The cost structure included estimates for fixed and variable expenses and indicated that the industry's fixed costs differed from the general pattern of agricultural processing industries because of the relatively high cost of product promotion in retail markets. Variable cost data for raw materials (60.4 percent of sales) and direct operating costs (25 percent of sales) were also presented.

The ability of corn dry mill plants to generate new investments funds does not differ from those of the milling industry as discussed in the section on bulgur processing.

Dry Corn Milling Pricing

Prices in the industry involve three principal products: corn grits, corn meal, and corn flour. These products account for 70 percent of the total weight of the corn milled. The data of the Census of Manufactures indicate that the industry's total value of shipments for 1967 was $270.6 million when 117 million bushels were milled. When the 1972 production figures become available they will indicate continuing trends toward the production of brewer's grits and corn flow and away from whole corn meal and grits used for purposes other than brewing.

The cry corn milling industry uses so minor and declining a portion of corn supply, that corn availability does not constitute a limiting factor of production. The industry does purchase shelled corn competitively with feed manufacturers and is affected by conditions which influence the feed market. Recent livestock feed demands and unusual increases in grain exports have disrupted the corn markets in which the corn mill industry must purchase its major raw material.

III. SIC 2044: RICE MILLING

Rough or hulled rice is milled by either conventional, regular milling (dry process) or parboiled rice milling (a wet steeping process). Because only parboiled rice milling requires water pollution control, this study concerns only the latter process.

Industry Segments

Of the 42 rice mills in the U.S. which are operated by 36 firms, only 6 mills use parboiling operations and of those, 5 have both dry and wet processing operations. Only one plant is solely a wet process mill. Compared to the rest of the industry, parboiling plants are large. They tend, also, to be forward integrated into packaging and distribution functions.

Compared to the rice milling industry as a whole, parboiling plants tend to be older plants with modern equipment and are generally located in Southern rice growing areas. Secondary data indicate that average plant employment runs from 125 to 175. Total rice milling industry employment is currently about 4,000 with approximately 900 or 22.5 percent employed in parboiling plants.

Wastewater in parboiling plants is produced as drainage from the parboiling operations and as waste from steam production. Because parboiling wastewater contains considerable BOD, COD, and dissolved solids loadings, treatment requirements are significant.

Financial Profile

The limited financial data on the rice milling industry as a whole was used to construct a model plant of 500 cwt/hour production capacity. Though smaller than some actual plants, the model adequately reflects the impact costs on the industry plants of water treatment facilities. The model assumed an operation at 100 percent of capacity for a 240 days x 16 hours per day year (4,000 hours).

The model indicated after-tax ROI at 6.0 percent and after-tax earnings on sales of 1.6 percent. Annual cashflows of $466,000 (3.2 percent of sales) are comparable to other milling industry ratios. Salvage values are positive for parboiling plants and are roughly estimated at 50 percent of book value for well-located, good condition plants. The capital structure of the model plant yielded sales of $3.90 for each $1.00 of investment, a level typical of agricultural processing industries where value added is not especially high. Too, the cost structure showing a relatively low cost component is similar to that of other agricultural processing industries.

Data for 1971 show financial conditions characterized by a low, long term debt of only 7 percent of net worth and before-tax profits of 11 percent of net worth. Under such conditions, the industry is in an excellent position to finance new investment.

Pricing

Price determination depends upon specific and products and byproducts of rice milling and their respective markets. Demand factors for milled rice include a high proportion of export shipments (two-thirds of which are financed under Title I of P.L. 480) for milled rice excluding hulls, brans and polish. Domestic trade accounts for 40 percent of the total of U.S. milled rice and is used by direct food processors, processed food firms, and breweries. The industries byproducts--hulls, brans, and polish--are used in the livestock, pharmaceutical and specialty food industries. Nearly half of the hulls from rice milling are not used and constitute a waste disposal problem. The total demand for parboiled rice has been increasing and shows an increasing demand in export markets. The supply of U.S. rice was, until recently, largely controlled by government support programs and acreage allotments.

IV. SIC 2046: WET CORN MILLING

The corn wet milling industry mills and refines corn (or milo) by the wet process. All plants in the industry have wastewater emissions and are, therefore, included in the study. The industry has 17 plants (generally in the Midwest) owned by 13 firms. Most of the major firms are engaged primarily in food and kindred products industries and produce a wide-variety of products.

Most plants are relatively old, but constant replacement has kept their processing equipment technologically modern. The study grouped plants by size--small, 15,000-50,000 bushels per day; medium 51,000-80,000; and large, 81,000-115,000--and estimated a total labor force in 1970 of 13,700. The industry processed approximately 250,000,000 bushels of corn in 1972.

The study's representative segment included plants of all three sizes since each has water emission problems and potentially significant impact effects from pollution controls. Of the 17 plants, 12 discharge into municipal treatment works and 5 utilize surface water receptors; hence, pollution treatment must be varied.

Financial Profile

Industry financial data are limited. Some data exist for selected company statistics in standard industrial indexes, but most must be extrapolated from 'firms' parent conglomerate reports. In the absence of sufficient data, the study constructed and relied upon model plant data. The model reflected data for firms in the three size ranges listed above.

The model revealed financial data as:

- After-tax ROI = 5.1%
- After-tax earnings on sales - 3.7%
- Annual cashflow = 9.3% of sales (relatively high for agricultural processing industries)
- Assets salvage values = significantly high for well-located good condition plants
- Capital structure = generally high capitilization requirements with an average sales of $1.39 per dollar of investment which is relatively low in the agricultural processing industries
- Cost structure = fixed costs represent 7.4% of sales and variable costs are relatively high at 42.1% of sales
- Ability to finance new investment = equity financing has been relatively unattractive from 1965-1972.

Pricing

Demand in the corn wet milling industry is wide-spread for both home and industrial consumption and most plants process a large product line. The industry processes about 250,000,000 bushels in 1972. The supply of raw materials is not a limiting factor of production because the industry processed only 4.3 of the total corn utilized. Purchases are made in markets dominated by livestock feed manufacturers.

Pricing is difficult to determine in the industry because of its unusually high number of products. Too, pricing factors frequently change by product and by the number of separate and unrelated markets. Some markets are made highly competitive because of the availability of product substitutes. The representative model plant analysis reflected pricing data for the 1967-71 period.

V. ECONOMIC IMPACT METHODOLOGY

The preceding industry characteristics were integrated with estimated pollution control requirements as established under the Federal Water Pollution Control Amendments of 1972 to serve as the basis for the present impact analysis.

Three levels of wastewater treatment were considered for each applicable segment of the grain milling industry:

Level I: (BPT)	Best practicable control technology currently available--to be met by 1977.
Level II: (BAT)	Best available technology economically achievable--to be met by 1983.
Level III: (NSPS)	New source performance standards--to be applied to all new facilities that discharge directly to navigable waters--to be met by approximately January 1, 1974.

In the impact analysis, NSPS were considered the equivalent of BAT. The specification and costs for each treatment level were supplied by EPA. To assess the sensitivity of impacts to the estimated pollution control costs, a range of estimated costs of plus or minus 30 percent were also analyzed.

The examined impacts were (1) price effects, (2) financial effects, (3) production effects, (4) employment effects, (5) community effects, and (6) other effects.

In general, the approach used can be simply stated as the problem of deciding whether a commitment of time or money to a project is worthwhile in terms of the expected benefits. The primary factors involved in assessing the financial and production impact of pollution control are profitability changes and these, in turn, are a function of the cost of pollution control and the ability to pass along these costs as higher prices. In reality, of course, closure decisions are seldom made on the basis of well-defined economic rules. Such decisions invariably include a wide range of personal values, external forces such as the ability to obtain financing, or the role of the production unit in an integrated larger cost center.

However, the analysis was made on the premise that economic returns in the industry would be the primary determinants of plant closures. In the most fundamental case, a plant will close when variable expenses (Vc) are greater than revenues (R). A more probable situation is the case in which $Vc < R$, but revenues are less than variable costs plus fixed, short-run cash overhead expenses (TC_c). In this siuation, a plant would likely continue to operate in the short-run, but would be forced out over a longer period of time. Necessary to such a situation is the firm's expectation that revenues will increase to cover total cash outlay. Identification of plants where $TC_c > R$, but $Vc < R$ leads to an estimate of plants that should eventually close if revenues do not increase.

The next level of analysis, where $TCc < R$, involves estimating the earnings before and after investment is pollution abatement. Under conditions in which $TCc < R$, it seems likely that investment in pollution control will be made and that plant operations will continue so long as the capitalized value of earnings (CV) is greater than the salvage value of the sunk investment of the plant. Computation of CV involves discounting the future earnings flow to the present worth. Discounted internal rates of return (the computed discount rate, or yield, which produces a zero present value of the cash flow) was the measure of profitability used. These rates of return, with and without pollution controls and the estimated salvage values of plant, equipment and land were the major factors used to determine plant shutdowns.

Price Effects

In order to provide a standard to reflect price effects, an estimated price adjustment sufficient to offset required pollution control costs was calculated. Application of the discounted cash flow procedure to pollution control costs yields present values and from this the price increase required to pay for pollution control was calculated by the formula:

$$X = \frac{PVP\ (100)}{(1-T)(PVR)}$$

where:

X = required percentage increase in price
PVP = present value of pollution control costs
PVR = Present value of gross revenue starting in the year pollution control is imposed

Production Effects

A study of the technological characteristics of the industry and of industry production practices underlay the analysis of probable changes in plant capacity utilization and in the industry's ability to absorb capacity losses as marginally productive plants are closed.

Employment Effects

Given the production effects of estimated production curtailments, of plant closings, and of changes in industry growth, employment effects were estimated on the basis of known production-employment relationships.

VI. POLLUTION CONTROL REQUIREMENTS AND COSTS

Data for pollution control technology and costs for this study were provided by the EPA. The data, integrated with model plant data prepared for this study, provide an adequate cost basis to determine the economic impact of pollution control on those segments of the grain milling industry encompassed by this study. The study applied BPT and BAT requirements to existing industry practices and technology for each industry segment. Such requirements that would achieve a high level of waste treatment are described below.

Corn wet milling plants discharging into municipal treatment systems will require in-plant modifications of their discharge to lessen pollution discharge and guard against spills. Those discharging to surface waters must undertake major treatment activities. For BPT levels, such plants must use treatment processes for grit removal, ph adjustment, nutrient addition, 12-18 hours of aerated equalization, complete-mix activated sludge processing, secondary sedimentation, and sludge dewatering. BAT level treatments will supplement BPT requirements by adding deep bed filtration.

Corn dry milling wastewater results from corn washing and since little can be done to reduce wasteloads by in-plant modification, the entire wastestream must be treated. BPT treatment will consist of primary sedimentation, nutrient addition, complete-mix activated sludge, secondary sedimentation, and sludge dewatering. BAT treatment includes BPT requirements and requires deep bed filtration as well.

All existing bulgur processing plants discharge into municipal systems. Those new plants which will be concerned with meeting NSPS standards will be concerned with primary solids separation, biological treatment and final sedimentation separation of solids. Proposed effluent guidelines are: BPT processing which includes an activated sludge system with nutrient addition and secondary sedimentation; BAT processing supplements that for BPT with a deep bed filtration system.

Among rice milling plants only those engaged in parboiling have wastewater. In-plant controls do not influence the quantity or quality of discharge and no plant currently treats discharges into municipal system. New plants and any others that cease municipal discharge must employ biological treatment and final separation of solids by sedimentation. BPT treatment includes nutrient addition, a complete-mix activated sludge process, and secondary sedimentation. BAT treatment adds deep bed filtration to the BPT activated sludge system.

The costs for adopting such systems in existing grain milling plants were determined by EPA cost guidelines applied to representative model plants. DPRA supplemented its primary model data by projecting different size plant data whenever such seemed warranted. Sensitivity information for the data constructs was provided by varying pollution control costs by ± 30 percent for all cases examined.

VII. IMPACT ANALYSIS

Since most grain milling plants discharge into municipal systems whose treatment processes are adequate to control effluent pollution, the industry will not be likely to experience severe economic impacts through the imposition of EPA treatment standards.

The following discussion considers economic impacts on a subindustry basis: corn wet milling, corn dry milling, bulgur processing, and parboiled rice milling. The impact analysis included effects on (1) prices, (2) finances, (3) production, (4) employment, (5) community, and (6) "other". Because of the limited applicability of the proposed effluent limitation guidelines, many of these effects were minimal and were important on an individual plant rather than an industry basis.

Very few (5) corn wet milling plants discharge directly to surface water; therefore, pollution controls will not severely affect the industry. Individual plant waste technology is such also that no plant need close because of pollution controls. The competitive nature of the industry, its current financial status, and its ability to finance new costs for pollution control argue that costs and pricing structures to offset these will not result in plant shutdowns. Employment, community, and other effects will be minimal. The only difficulty that pollution controls will impose on the industry may be one affecting its growth. Municipal treatment systems may prove inadequate to receive large quantitative increases in wastewater.

Corn dry milling plants will also not be severely affected by pollution control costs. Their present profitability, financial conditions, and production technologies are sufficient to absorb those additional costs which cannot be passed through to purchasers. Employment, community, and "other" effects will be most minimal and ineffectual.

All existing bulgur and parboiled rice plants discharge into municipal systems; consequently, no economic effects will be felt by these industries. NSPS standards will not by themselves present new plant construction for either industry.

VIII. LIMITS OF THE ANALYSIS

The data for this study were compiled from various responsible sources in government, industry, and research facilities. Though subjective judgments were applied where necessary, they were examined against known factors. Obviously, however, the grain milling industry is complex enough in its supply and demand determinants, its pricing, and its technology to recognize that any study of the industry must recognize its limitations.

Because of the unavailability of data, DPRA based this study on model plant projections which are by nature susceptible to error ranges as outlined. These must be kept in mind as critical assumptions concerning the industry are made. In addition, assumptions were made regarding industry technology and financial conditions and pollution control requirements which are critical to the impact analysis. These assumptions are outlined in the critical assumptions section.

ECONOMIC ANALYSIS OF EFFLUENT GUIDELINES
GRAIN PROCESSING SEGMENT OF THE GRAIN MILLS INDUSTRY

PHASE I - INDUSTRY DATA AND ANALYTICAL FRAMEWORK

I. INTRODUCTION

The total grain mill products industry (SIC 204) is currently comprised of seven four-digit industries. This study considers three of the seven:

SIC	2041	Flour and Other Grain Mill Products (Flour only)
SIC	2044	Rice Milling
SIC	2046	Wet Corn Milling

In 1967, the three selected four-digit industries accounted for 20.4 percent of the establishments and 34.7 percent of the employees of the total grain mill products industry. (The other four-digit industries in grain milling which are excluded from this study are SIC 2043 - Cereal Breakfast Foods, SIC 2045 - Blended and Prepared Flour, SIC 2047 - Pet Food, and SIC 2048 - Prepared Feeds.)

A brief description of each industry included is as follows:

SIC 2041 -- Flour and Other Grain Mill Products

This industry comprises establishments primarily engaged in milling flour from grain, particularly wheat. Products are sold to the baker for manufacture into bread and cake products or to grocery stores for sale to the consumer in packaged form. Durum products are sold to macaroni and spaghetti manufacturers. Flour is also sold or used in prepared mixes. Bulgur, a specialty wheat product requiring water for processing, is also produced in this industry. Corn dry milling, the major products of which are corn grits and corn meal and flour, is also included in this industry.

SIC 2044 -- Rice Milling

This industry includes establishments primarily engaged in the cleaning and polishing of rice and in the manufacture of rice flour or meal. Important products of the industry include milled rice, brown rice, rice polish, rice bran, and rice flour. Conventional rice milling is a dry process, but parboiling operations are an important segment of the industry which utilizes water for processing.

SIC 2046 -- Wet Corn Milling

This industry is mainly comprised of establishments engaged in milling corn or grain sorghum (milo) by the wet process. Products include starch, syrup, sugar, oil and such by-products as gluten feed and meal. Establishments manufacturing starch from other sources such as wheat, rice and potatoes are also included in this industry.

Each of the above industries involves unique products, production processes and other specialized characteristics; hence in determining the economic impact of the costs of alternative levels of pollution abatement, each industry will be separately considered. As an overview of the general size of each industry, number of establishments in each of the three selected industries, as reported by the U.S. Census of Manufactures, were as follows in 1963 and 1967.

Industry	No. of Plants		No. of Companies	
	1963	1967	1963	1967
2041 Flour and Other Grain Mill Products	618	541	510	438
2044 Rice Milling	74	68	62	54
2046 Wet Corn Milling	60	45	49	32

Flour and Other Grain Mill Products plants have been steadily declining in number for many years. Rice Milling and Wet Corn Milling plants reached a peak in 1963 and have subsequently declined.

The plan of this report is to discuss each of the above industries separately because of their rather marked differences in the types of processes involved, differences in products produced, and differences in their effluent control requirements.

II. SIC 2041: FLOUR AND OTHER GRAIN MILL PRODUCTS

Establishments in SIC 2041 tend to further group into four separate sub-industries on the basis of primary products produced. These four groupings, representing different product classes, are as follows:

SIC	Description
20411	Wheat flour, except flour mixes
20413	Corn mill products
20415	Flour mixes, refrigerated doughs made in flour mills
20416	Other grain mill products

The largest, SIC 20411, represents approximately 75 percent of the total industry shipments.

Based upon industry contacts and discussions, only very limited portions of this industry have any water pollution control problems. In particular, only two portions of the overall industry have potential water pollution problems associated with milling per se:

(1) Bulgur (wheat) processors - washwater and/or "steepwater" drainage
(2) Dry Corn Millers - washwater

Most of the corn dry millers using the tempering-degerminating process have large capacities and wash corn as one step in the cleaning process. Since smaller mills producing ground whole corn apparently do not wash corn, they are excluded from this study.

Wheat flour millers, the largest single category of SIC 2041, are not generally concerned with water pollution problems. Correspondence with the Miller's National Federation, a national association of the flour milling industry, indicated that "...most of the mills certainly do not feel that they have any real effluent problem in their flour milling operations ..." This confirmation of the absence of water pollution problems in flour milling suggests that no further study is probably needed.

As a further check, the results of an informal survey by the Technical Committee of the Association of Operative Millers was made available to DPRA. This committee is essentially superintendents of grain mills from companies dispersed throughout the U.S. including those from wheat, dry corn and bulgur mills. A survey of 17 of the committee's members concerning actual or anticipated water pollution problems indicated that only 7 considered that they had some water pollution problems in wheat milling; however, the major problem with water was not in milling per se, but in bulk rail car washing processes. A summary of the results of this 'survey' are presented in Table II-1. Also noted is that three companies had one or more mills in which some (5 to 7 percent) milled wheat was washed.

Regarding dry corn milling (note only four members represented corn mills), four indicated that all corn milled for human consumption was washed, involving from 5 to 7 gallons of water per bushel. The extent that this creates a problem was not certain, although three discharge into municipal sewer systems.

Three members were from companies which had bulgur mills. In this case, no respondent indicated that they had a special waste water disposal problem with bulgur. This response is not conclusive, however, since different processes exist in bulgur production.

With respect to SIC 2041, two subindustries will be studied further: Bulgur processing and corn dry milling. Wheat flour millers may have some problems with rail bulk car washing wastes, but no further assessment is planned herein.

Bulgur Industry Segments

Bulgur production was established in the U.S. on a commercial basis in the mid-to-late 1950's. The original producers marketed primarily to ethnic oriented outlets, e.g., Armenian. However, since that time, domestic use has been eclipsed by export sales via U.S. export trade programs, especially under USDA relief programs and Title I of PL 480.

Table II-1. Responses from 17 members of the Technical Committee of the Association of Operative Millers concerning water pollution problems in grain milling

Wheat Milling	Yes	No	No Response
Do you have a water pollution problem?	7	10	0
If you do, is it because of wheat washing?	3	5	9
- bulk car washing?	7	1	9
- bulk truck washing?	2	2	13
- wet scrubber dust collecting?	0	4	13
- other	0	0	17
If other - what?			
Wheat Washing			
If you wash wheat, what % is washed?	(5-7%)		
How many gallons of water per bushel are used?	(4 gallons)		
Does the water go straight to the sewer?	10	1	6
Bulk Car and Truck Washing			
If you use water to clean bulk cars or trucks, about how many gallons per car are used?	(1,500 gallons)		
Does it go straight to the municipal sewer?	11	1	5
Is there a special charge for this?	7	3	7
Do you expect to be required to treat this water?	4	4	9
Bulgur (Note: Only 3 had bulgur mills)			
If you make bulgur, is there a special waste water disposal problem?	0	1	16
Dry Corn Milling (Note: Only 4 had corn mills)			
Do you wash all corn to be milled for human consumption?	4	0	13
How many gallons of water per bushel?	(5-7 gallons)		
Does the water go straight to the sewer?	3	1	13
Water Treatment			
Do you have a water treatment system?	1	11	5
Do you use strainers?	8	3	6
Do you use settling tanks?	5	5	7
- other?			
What other? Starch/gluten a big problem - recover solids for resale but quite expensive			

Types of Firms

Six U.S. milling firms are now actively engaged in the production of bulgur on a commercial basis. Since the late 1950's there have been at least 17 processors who have entered into bulgur production, but now only six firms remain active. The most recently closed mill, which is presently being dismantled, is one owned by Far-Mar-Co., Inc. in Hutchinson, Kansas. This plant was a 'medium'size plant relative to the rest of the industry.

The six firms each have but one bulgur mill (see TableII-2 below). In every case, the firms have other milling units and bulgur would generally be considered a relatively small part of the overall firms operations. For example, three of the firms are among the top twenty wheat flour millers in the U.S.

Types of Plants

The six remaining bulgur plants in the industry are as shown in Table II-2. Also shown are the plant locations and the estimated capacities per day for each plant. Bulgur mills are dispersed throughout the midwestern and western states. One plant each is in Kansas, Nebraska, Oklahoma, Texas, California and Washington. The Fisher mill in Seattle, Washington is the dominant plant in the industry.

Capacities range from 2,500 cwt. to 9,000 cwt. per day; and an average capacity is approximately 5,000 cwt. per day. The composite annual capacity of the industry is slightly over ten million hundredweight. In 1971 and 1972, bulgur production totaled about five million hundredweight. Hence, utilization of capacity is about one-half of capacity (based on 330 days, 24 hours per day).

Because of the relative newness of the industry, the level of technologies is reasonably modern. However, there are a variety of processes for bulgur production and each requires different equipment.

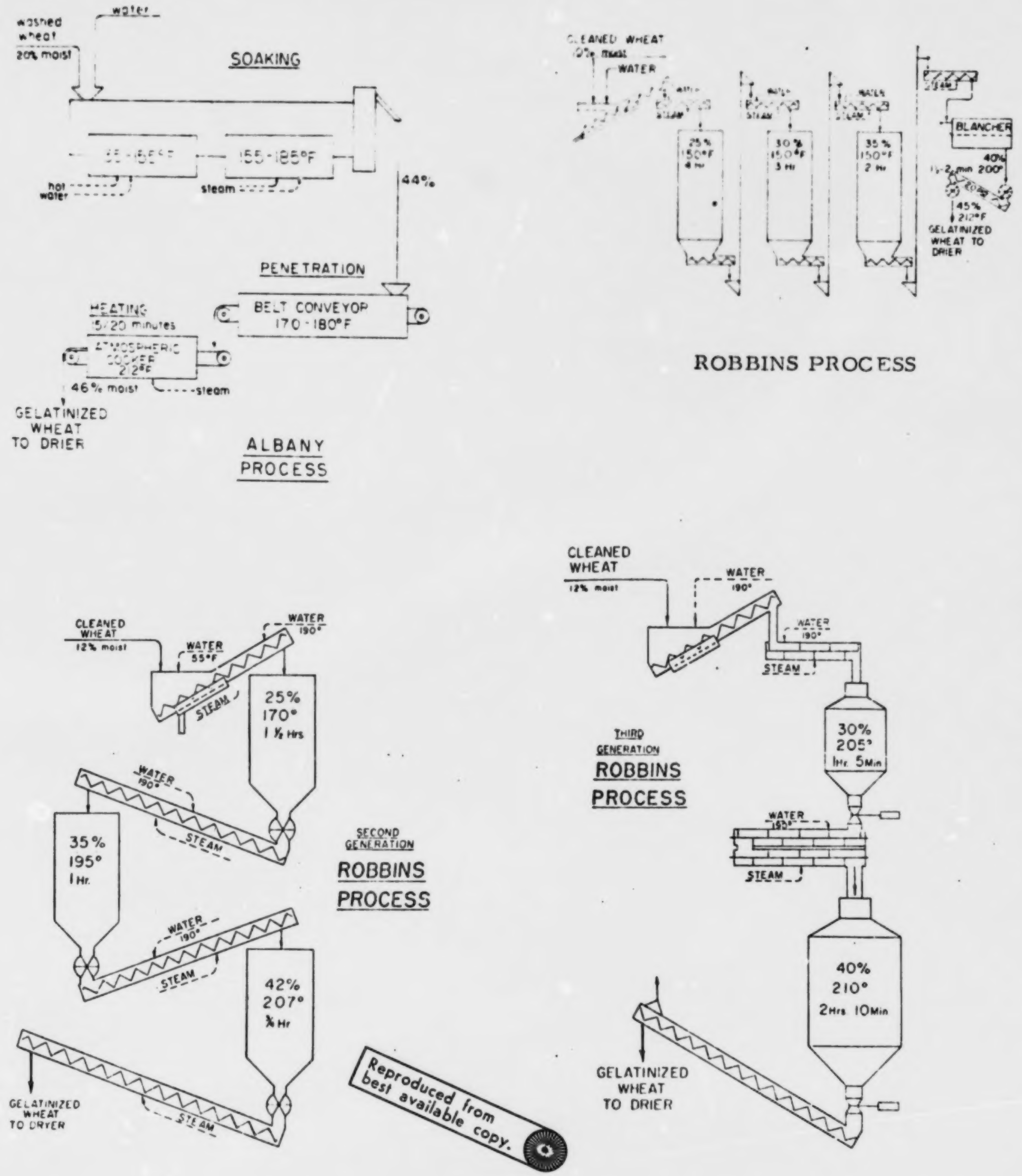
Four processes for gelatinizing wheat to produce bulgur are illustrated in Figure II-1. These are referred to as: (1) Albany process, (2) Robbins process, (3) second generation Robbins process, and (4) third generation Robbins process. Only the Albany process involves any wastewater drainage from the hydration procedure. Otherwise, all process water is eventually vaporized in driers. (Another water-use step may be wheat washing prior to processing, but no plants are known to now wash wheat.)

Table II-2. Listing of bulgur mills and their plant locations

Bulgur Plants and Location	Estimated Capacity (cwt/day)
Archer Daniels Midland Co. Shawnee Mission, Kansas 66207 Plant: Abilene, Kansas	5,000
Burrus Mills, Inc. Dallas, Texas 75201 Plant: Dallas, Texas	3,200
California Milling Corp. Los Angeles, Cal. 90058 Plant: Los Angeles, California	4,500
Fisher Mills, Inc. Seattle, Washington 98134 Plant: Seattle, Washington	9,000
Lauhoff Grain Co. Crete, Nebraska Plant: Crete, Nebraska	6,500
Leger Mill Co. Altus, Oklahoma 73521 Plant: Altus, Oklahoma	2,500

Sources: "Bulgur Mills," The Northwestern Miller, Vol. 278, No. 9, September, 1971.

Fisher, Glen W., The Technology of Bulgur Production, Association of Operative Millers, Bulletin, May, 1972.


washed wheat
20% moist
water
SOAKING
155-185°F
155-185°F
hot water
steam
44%
PENETRATION
BELT CONVEYOR
170-180°F
HEATING
15/20 minutes
ATMOSPHERIC COOKER
212°F
46% moist
steam
GELATINIZED WHEAT TO DRIER
ALBANY PROCESS
CLEANED WHEAT
10% moist
WATER
STEAM
25%
150°F
4 Hr
30%
150°F
3 Hr
35%
150°F
2 Hr
BLANCHER
40%
1½-2 min 200°
45%
212°F
GELATINIZED WHEAT TO DRIER
ROBBINS PROCESS
CLEANED WHEAT
12% moist
WATER
55°F
WATER
190°
STEAM
25%
170°
1 ½ Hrs
WATER
190°
STEAM
35%
195°
1 Hr.
WATER
190°
STEAM
42%
207°
¾ Hr
STEAM
GELATINIZED WHEAT TO DRYER
SECOND GENERATION
ROBBINS PROCESS
CLEANED WHEAT
12% moist
WATER
190°
WATER
190°
STEAM
30%
205°
1Hr. 5Min
WATER
150°
STEAM
40%
210°
2Hrs 10Min
GELATINIZED WHEAT TO DRIER
THIRD GENERATION
ROBBINS PROCESS

Reproduced from best available copy.

Figure II-1. Illustration of modern bulgur gelatinization processes.

Number of Plants and Employment by Segment

Of the six remaining plants in the industry, two each might be classed as small, medium and large. Employment data is not published, but estimated employee requirements (assuming each mill only processed bulgur) range from about 20 to 45 per mill based on size. Total employment is estimated at approximately 180 to 210 as follows:

Plants	Plant Range	No. Mills	Total
Small	20-25	2	40-50
Medium	30-35	2	60-70
Large	40-45	2	80-90
Total		6	180-210

Selection of Segments to Total Industry

All plants with drainage and/or other wastewaters, e.g., wheat washing, will be affected substantially if waste treatment facilities must be installed at the plant level. The plants by size class are estimated to have the following distributions regarding production and employment.

Plants	% of Production	% of Employment
Small	19	23
Medium	31	33
Large	50	44
Total	100	100

Again, only six plants are involved.

Likely Impacted Segments

Within the size range of plants involved, all would likely be affected substantially with increased costs associated with pollution control facilities if required. Thus, no plants are eliminated due to size. However, as noted above, if no washing occurs, and if a Robbins process is used, then no wastes of consequence are believed involved. These plants may be eliminated. (Steam generation water wastes and sanitary wastes are excluded.)

To determine how much the study scope might be narrowed on the basis of type-of-process used, a poll was made concerning all the bulgur plants. The results were as follows:

1. No wheat washing (except "steeping") is practiced.
2. No plant indicated that water wasteflows were a problem.
3. Only minor overflows (excess water drainage) were experienced in "steeping" wheat. The objective is to add water only to the level which can be retained by the wheat mix.

From all indications the bulgur plants do not have a significant water pollution control problem. Only minor volumes of wasteflow are indicated and these are apparently being discharged for adequate treatment.

Bulgur Financial Profile

Financial data on the bulgur industry per se are not available. Bulgur operations comprise a portion of larger more complex milling organizations, primarily wheat flour milling. To assess this industry, it was necessary to resort to model plant data representing the industry. Within the time frame available, attention was focused on a 'medium' sized operation to reflect industry averages.

Plants by Segment

Bulgur processing is a rather straight forward milling process with only bulgur as the primary product (a small amount of millfeed byproduct is also produced). Sizes of units range from about 2,500 to 9,000 cwt. per day. The medium plant modeled herein is rated at 5,000 cwt. per day.

Small, medium and large categories of plants would be defined as:

Small	2,500 - 4,000 cwt./day
Medium	4,000 - 6,000 cwt./day
Large	6,000 - 9,000 cwt./day

As stated, only a medium sized plant was modeled to reflect average conditions in the industry at this time. A characteristic of the industry is that only about one-half of the maximum machine capacity is being utilized to meet demand requirements. For example, the medium 5,000 cwt./day plant has a rated annual capacity of about 1.65 million cwt. (7,920 production hours), but throughput volume estimated is 0.832 million cwt. (4,000 production hours) or approximately 50 percent of the maximum.

Annual Profit before Taxes

Based upon the model plant concept and the operating assumptions employed, estimated annual pre-tax income and selected rates of return on average fixed investment are as shown in Table II-3. After tax ROI is estimated as 7.0% and after tax earnings on sales are a relatively low 1.7%. Earnings are sensitive to changes in sales prices, e.g. a 1% change in price downward would reduce after tax ROI to 4.4%

Table II-3. Estimated pre-tax net income and rate of return on average invested capital and after-tax return on sales for a medium bulgur processing plant

Financial Measure	Value
Pre-tax net income ($000)	171
Pre-tax ROI* (%)	12.6
After-tax ROI* (%)	7.0
After-tax return on sales (%)	1.7

No bulgur processing plants are believed to have maintained high profit levels because of the generally low utilization rates (and limited bulgur demand) in the industry. The recent closure of the Far-Mar-Co. plant at Hutchinson, Kansas, which was a medium sized plant, suggests also the questionable profitability of bulgur processing.

Average fixed investment, on which the rates of return were calculated, was derived by dividing replacement costs by two (an estimate of average fixed assets) plus total working capital (current assets) less current liabilities (based on grain milling industry averages). The average fixed or invested capital estimate is intended to approximate invested capital in reported financial data. After tax income was based on a 48% tax rate without either carry forward or back tax provisions.

Annual Cashflow

Estimated annual cashflow (after tax income plus depreciation) and return on average fixed investment are as shown in Table II-4 for the selected model plant. Depreciation for the plant was based on an expected 25 year life for buildings and 15 years for equipment.

The cashflow data are considered nominal for grain milling firms. It is expected that pollution control cost impacts can be assessed adequately given conditions reflected in the cashflow data shown plus subsequent scale adjustments.

Market (Salvage) Value of Assets

No data is generally available concerning salvage values of bulgur plants per se. Bulgur plants appear to have little value t others in the industry under the present condition of major underutilization of maximum plant capacities. However, some components of bulgur operations (e. g. aspirators, elevators, dryers, etc.) are common to the grain milling industry and salvage values might be estimated on a dismantled plant basis.

Capital Structure - Agricultural processing industries generally require a relatively low investment per dollar of sales. This is true of bulgur processing where an investment of $1.00 results in sales of $4.22 based on the model plant data developed.

The capital required to generate such sales for the model bulgur plant is indicated in Table II-5. The estimated replacement value of fixed investments as shown includes land, buildings, equipment and associated installation costs. Excluding land, the total plant investment cost was

Table II-4. Estimated cash flow for a medium bulgur processing plant

Financial Measure	Value
Annual cash flow ($000)	143
Cash flow on average fixed investment (%)	11.0

65% for buildings and 35% for equipment based on an engineering synthesis of model plant data by DPRA.

Total working capital requirements of $1.36 million, as also presented in Table II-5, exceed the $1.089 million in plant and equipment. This working capital requirement equals about 25% of annual operating costs. Thus, while bulgur processing is not particularly capital intensive, it does have substantial working capital requirements. As a part of salvage value that would be recoverable in case of plant closure, the working capital component is significant, i.e. 55% of replacement value of total assets.

Cost Structure - Model plant data and budgets were prepared to estimate the cost structure of representative operations.

Fixed or plant related expenses were defined as those which do not directly vary as a function of throughput. These expenses include:

- maintenance and supplies
- taxes and insurance
- plant and labor overhead
- sales, general and administrative

Additionally cost estimates were made for depreciation and interest costs. Variable or production related expenses were defined as those which will generally vary proportionately with throughput -- in other words, a fixed amount per unit processed. They include:

- raw materials
- power
- water
- process supplies, chemicals, etc.
- operating labor
- plant supervision and fringe benefits

Fixed costs - As shown in Table II-6, the indirect operating costs for the budgeted medium bulgur processing plant represent only 3 percent of sales. This is due to the dominance of raw grain purchases as input and the relatively low value added process that is involved. Presumably, smaller plants would have relatively higher fixed costs and larger plants relatively lower.

Depreciation is also a small percent of sales, 0.9%, as shown. This again reflects the low fixed asset capital requirements of bulgur production relative to other inputs.

Interest costs are shown as equal to 1.0% of sales for the model plant.

Table II-5. Estimated replacement value and working capital requirements for a medium bulgur processing plant

Capital component	Requirement
	($000)
Replacement value of plant, equipment & site	1,089
Total working capital	1,360
Replacement value of total assets	2,449

Variable costs - Variable costs are also shown in Table II-6 for two major components; raw materials, and other direct operating costs. Raw materials costs represent almost 80% of sales and is overwhelmingly the most dominant production cost component. This is expected, however, in processes like bulgur production where the processing is rather simple and straight forward.

Direct operating costs are second in importance relative to sales, and the model plant direct costs were estimated as equal to 12.1% of sales. This percentage is expected to vary among plant sizes as is to be determined in subsequent study.

Distribution of Model Plant Financial Data

There was no known individual plant financial data concerning bulgur operations in published sources. Consequently, the contractors had to rely upon model plant cost and returns data which were generated specifically for this study. Because bulgur processing is generally straight-forward and not overly complex, it was possible to design and simulate engineering cost estimates for the model plant specified within the time constraint of this study. Unfortunately, alternative mill sizes could not be developed for comparative purposes. However, the "medium" size plant was chosen to best reflect what might be termed average conditions in the industry.

Most of the financial data generated has been summarized above. However, a composite summary plus key assumptions and some selected additional data are presented in Table II-7.

The Protein Cereals Products Institute, an industry association, represents the bulgur producers. The institute does not collect or analyze data relating to plant production costs, productivity and profitability. Thus, this source was not asked to verify production data. Also, time did not permit verification with producers.

Wherever data were missing it was necessary to make personal judgments and approximations. Selected financial data and ratios, such as from IRS business statistics, Dun & Bradstreet, Standard & Poors, Fortune and other sources were used as guides and indicators of likely plant characteristics. Census of Manufacturers data was also used concerning the grain mill products industry in general and also for selected four-digit industries such as SIC 2041.

Current industry prices and costs were used for the bulgur plant operation, i.e., first quarter, 1973. Investment requirements reflect recent costs including adjustments for inflation based on judgment.

Table II-6. Estimated costs for a medium bulgur processing plant

Item	$000	Percent
Sales	5,724	100.0
Raw materials	4,576	79.9
Direct operating costs	692	12.1
Indirect operating costs	173	3.0
Depreciation	54	0.9
Interest	58	1.0
Total before-tax cost	5,553	97.0

Table II- 7. Summary of financial data pertaining to the bulgur processing model plant

Item	Units	Value	Remarks
Utilization	%	50	4,000 production hours
Annual Thruput	1,000 cwt	832	50# bags
Sales	$1,000	5,724	$7.40-.52 (transport) = $6.88 FOB Mill
Raw Product Cost	"	4,576	1.1 (Thruput) ($5.00)
Variable Costs	"	692	
Fixed Costs	"	173	
Cash earnings	"	283	
Depreciation	"	54	4% Bldg, 6.7% Equip.
Interest	"	58	$.07/cwt
Pre-tax income	"	171	
Net income	"	95	
After-tax cash flow	"	149	
Replacement Cost	"	1,089	Engineering synthesis
Working Capital	"	1,360	25% Operating Costs
Current Liabilities	"	544	40% Total Working Capital
Ave. Fixed Invest. (AFI)	"	1,361	
Pre-tax income/AFI	Ratio	.126	
Net Income/AFI	"	.070	
Cash Flow/AFI	"	.110	
Net Income/Sales	"	.017	

Ability to Finance New Investment

The ability of a firm to finance new investment for pollution abatement is a function of several critical financial and economic factors. In general terms, new capital must come from one or more of the following sources: (1) funds borrowed from outside sources; (2) equity capital through the sale of common or preferred stock; (3) internally generated funds--retained earnings and the stream of funds attributed to depreciation of fixed assets.

For each of the three major sources of new investment, the most critical set of factors is the financial condition of the individual firm. For debt financing, the firm's credit rating, earnings record over a period of years, stability of earnings, existing debt-equity ratio and the lenders' confidence in management will be major considerations. New equity funds through the sale of securities will depend upon the firm's future earnings as anticipated by investors, which in turn will reflect past earnings records. The firm's record, compared to others in its own industry and to firms in other similar industries, will be a major determinant of the ease with which new equity capital can be acquired. In the comparisons, the investor will probably look at the trend of earnings for the past five or so years.

Internally generated funds depend upon the margin of profitability and the cash flow from operations. Also, in publicly held corporations, stockholders must be willing to forego dividends in order to make earnings available for reinvestment.

The condition of the firm's industry and the general economy are also major considerations in attracting new capital. The industry was compared to other similar industries (i.e., other processing industries) in terms of net profits on sales and on net worth, supply-demand relationships, trends in production and consumption, the state of technology, impact of government regulation, foreign trade and other significant variables. Declining or depressed industries are not good prospects for attracting new capital. At the same time, the overall condition of the domestic and international economy can influence capital markets. A firm is more likely to attract new capital during a boom period than during a recession. On the other hand, the cost of new capital will usually be higher during an expansionary period. Furthermore, the money markets play a determining role in new financing; the 1973 year was viewed as especially difficult for new equity issues.

These general guidelines can be applied to the milling industry by looking at general economic data, industry performance and available corporate records.

There are no available financial data on firms operating bulgur plants. One must look at grain mill products as a whole in order to gain impressions about the profitability of the industry and the ability to attract capital.

Table II- 8 presents selected financial data on grain milling as a broad industry category for the years 1967-68 through 1971. The industry is below average in profitability, both as a percentage of sales and of net worth. Net profit on sales of 1.75 to 3.6 percent compares to Standard and Poor's 425 industrial companies' return on sales of 5.0 to 6.1 percent during those same years. Only in 1968-69, when return on net worth averaged 11.9 percent, did grain milling achieve the manufacturing average of approximately 12 percent. Returns were down in 1971, owing largely to higher corn prices and reduced profit margins.

The grain milling industry debt situation appears generally sound. Long-term debt averaged 21 to 36 percent of net worth, compared to a general range of 35 to 50 percent for most manufacturing industry groups. Current debt levels appear normal with ratios of 1.8 to 2.2. Assuming continued profitable operations, the industry should have adequate borrowing capabilities.

Cash flows, estimated as a percent of total assets, ranged from 7.3 to 9.3 percent in the thre-year period from 1967-68 through 1969-70, with the last year at 7.8 percent. Indications are that 1971 was even lower. Further analysis of grain mill products firms by asset size indicate that the cash flow may be somewhat higher for the largest firms (over $100,000,000 in assets); beyond that, asset-size appears to have little relationship to cash flow.

Profit margins in the milling industry in general tend to fluctuate from product to product and from year to year. Millers have little control over raw product costs, which usually reflect production changes and prices of related products. Thus, there is an instability of earnings in the industry which makes it somewhat less attractive for equity capital and usually requires lower debt/equity ratios than for manufacturing in general. Even so, there is no evidence that the milling industry cannot attract sufficient capital to finance new investment.

Table II- 8. Selected financial ratios for grain mill products firms, 1967-68 through 1971

	1967-68[1]	1968-69[1]	1969-70[1]	1971[2]
Net profits as % of sales	2.7	3.6	3.3	1.75
Net profits as % of net worth	9.9	11.9	11.1	8.3
Net sales times net worth	3.7	3.3	3.4	5.1
Net sales times net working capital	8.3	7.8	8.7	8.7
Net sales times total assets	2.1	2.1	1.9	N.A.
Total debt as % of net worth	80	60	80	98
Fixed debt as % of net worth	31	21	36	N.A.
Current ratio	1.9	2.0	1.8	2.2
Cash flow as % of total assets	7.3	9.3	7.8	N.A.

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[1] Troy, Leo, Almanac of Business and Industrial Financial Ratios in 1971, 1972 and 1973 editions, Prentice-Hall, Inc., Englewood Cliffs, N. J.

[2] Dunn and Bradstreet, 1971 Key Business Ratios--industry median; each ratio is for a different firm (73 companies).

Bulgur Pricing

Price Determination

Price determination for bulgur is somewhat unique in that most sales are to the U.S. government on the basis of tenders for bid from U.S. bulgur producers. Contracts are awarded to lowest bidders for specified quantities of bulgur which are packed to specification.

A summary of demand and supply relationships in the industry is presented to explain major factors affecting bulgur sales and prices.

Demand

Only a small portion of the yearly production of bulgur is sold in retail packages in the United States. Over 99 percent of the bulgur produced is bought under contract by the United States Department of Agriculture, and, approximately 99 percent of this amount is exported under various foreign aid programs, such as the P.L. 480 - Food for Peace program. A small portion about 3 million pounds of bulgur per year is distributed within the United States in federal school lunch and domestic feeding programs.

Four-fifths of the U. S. produced bulgur is shipped to Southeast Asia and about one-third of that goes to Indonesia. The USDA and the association of bulgur producers has concentrated its market promotion and educational efforts in that part of the world. Other areas which offer opportunities for future bulgur sales include other Asian countries, the Middle East, and the new African nations.

Bulgur is gaining acceptance in developing nations as a high-protein, high quality food. In recognition of the nutritional value of food, bulgur producers are increasing the protein value of bulgur by adding soy grits. This product, called soy fortified bulgur, is a fairly recent development and consists of 85 percent bulgur and 15 percent soy grits. The USDA has sharply increased its purchases of this product in the past two years due to the great interest shown by the developing nations.

Total sales of bulgur grew rather slowly to a level of about 5 million hundredweight in 1972. The trend in exports, representing approximately 99 percent of sales, is as shown in Figure II-2. Also shown is the distribution of sales to major export markets. The total volume of bulgur produced in the U. S. is equivalent to about one-half of one percent of the nation's annual wheat production.

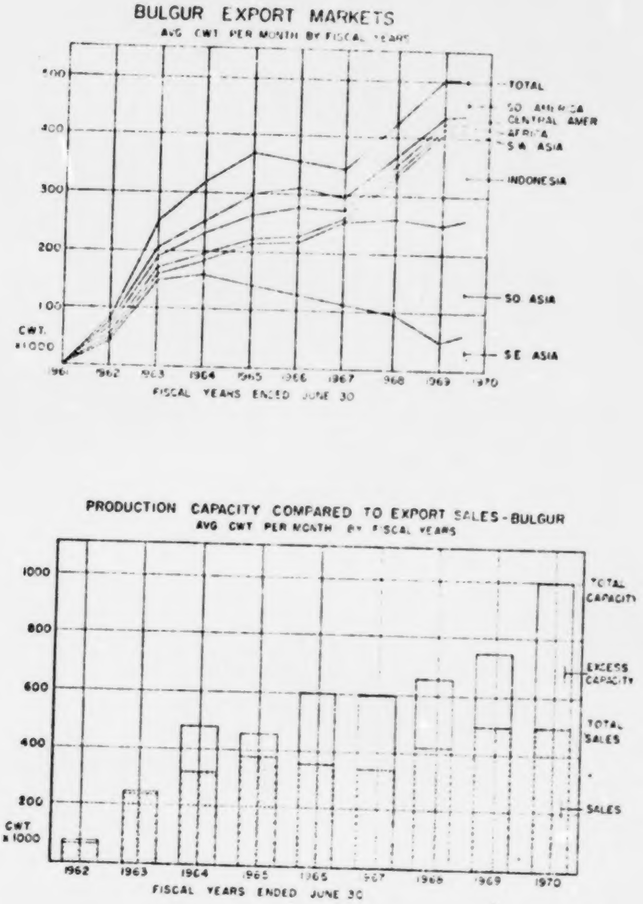

Figure II-2. Bulgur export sales and sales by market, 1962-1970.

Source: Fisher, Glen W., "The Technology of Bulgur Production," Bulletin, Association of Operative Millers, May, 1972, p. 3301.

Reproduced from best available copy.

Supply

Bulgur supplies are effectively equal to the USDA (ASCS) purchases for export programs and to a minor extent U. S. domestic donation programs. Less than one percent of the bulgur produced is distributed through regular commercial market channels. A summary of bulgur purchases by USDA since 1968 is shown in Table II- 9 .

Bulgur is produced according to rather stringent government standards and packaged in high quality bags (normally 50 pounds per bag) for export (and other) shipment. Also, since 1971, soy fortified bulgur has been produced and it is rapidly replacing stright bulgur production. This new product is still primarily bulgur (85 percent), but as government tenders for bid are changed, the industry firms have quickly added soy grits blending capability.

Prices

Bulgur prices of concern were essentially only those at the plant level. Domestic sales are of minor consequence relative to total sales; and no attempt was made to trace domestic sales beyond first the ethnic orientation of some markets, and second, some apparent increase in bulgur sales among health food stores.

Competitive bidding for bulgur (and soy fortified bulgur) production contracts effectively determines the mill price of bulgur. Presumably, bid prices reflect costs of production including wheat purchases and nominal rates of return. Also, however, most bid requests are for delivered port prices at specified sea coast and Great Lakes destinations, e.g., Gulf, West Coast, East Coast and Lakes. Availability of wheat supplies and the plant location could result in comparative advantages for individual mills or groups of mills when bidding for specific location-dependent contracts.

Bulgur prices vary directly and proportionally with wheat prices as expected (and now with soybean prices also). For example, bulgur prices in June, 1972 were $5.64 per cwt. f.a.s. at Gulf ports but rose to $7.83 in December, 1972. During this period, wheat prices also rose from about $1.52 per bushel to $2.62 or by $1.83 per cwt. After accounting for processing wheat losses (10 percent including moisture differential), the change in wheat costs accounts for almost all the change in bulgur prices.

In the first quarter of 1973, bulgur prices averaged about $7.40 per cwt. at Gulf ports. Wheat prices, delivered to mills, averaged $3.00 per bushel (or $5.00 per cwt.) during the same period.

Table II- 9. USDA purchases of bulgur for export and donation programs, 1968-1972

Year	Bulgur	Soy Fortified Bulgur	Total Exports	Bulgur for Domestic Donation
	(1,000 cwt.)			
1968	3,749	-	3,749	51
1969	4,165	-	4,165	47
1970	5,452	-	5,452	43
1971	4,070	980	5,050	35
1972	2,030	2,920	4,950	30

Source: National Food Situation, ERS, USDA, May, 1973.

Price Change

Because of the peculiar structure of the bulgur industry, i.e., 99 percent sales to the government for export under food-for-peace type programs and the contracting purchase system, it is first anticipated that any change in costs for pollution control would be reflected in contract bid "prices". Hence, costs would be passed-through just as is an increase in the cost of wheat input.

Second, however, can prices be passed to consumer (foreign countries) without a change in the quantity demanded? In this regard it is estimated that the demand for bulgur is price elastic (elasticity less than -1.0) where local currency sales are made; and, quantity demand would therefore be reduced noticeably given only small percentage changes in price. Thus, export requirements would be lowered and average utilization of plant capacity in the U. S. would be less. The least efficient plants would then have difficulty competing.

The smaller bulgur plants are expected to be impacted relatively more than the larger plants in terms of per unit costs of pollution abatement. These plants will first have trouble competing for contracts because of costs and subsequently they will also be further disadvantaged if aggregate demand falls in foreign markets.

Corn Dry Milling Industry Segments

This industry manufactures corn meal for human and animal consumption. Products for human consumption include whole corn meal, degermed corn meal, corn grits, and hominy. The industry also makes corn grits and flakes for use in the brewing industry. Some corn milling firms are engaged in the breakfast food and cereal based snack industries.

Types of Firms

116 firms operated corn dry mills in 1971.[1] Just 5 firms owned more than one corn dry mill. Four of these five firms--Quaker Oats Co., Con Agra, Gooch Mills, and Pabst Brewing Co.--are diversified food processing companies. The other 112 firms are primarily engaged in grain milling. A majority of the corn dry millers are regional or local firms and are relatively small.

The main products of corn dry milling are corn grits, corn meal, and corn flour. The byproducts are hominy feed and oil. The product spectrum can, and does, vary from day to day depending upon the type and quality of corn being milled and the product mix sought.

Types of Plants

Most corn dry mills are located in the Southeastern states (Figure II-3). In 1971, 124 mills dry milled corn as shown by state in Table II-10. [2] Of these 67 or 54% were situated in four states--Kentucky, Tennessee, Virginia, and North Carolina. The listed capacities of the mills ranged from 25 to 20,000 cwt per day of meal production.

The total number of corn dry mills decreased from 152 in 1965 to 124 in 1971 indicating small and marginal operators were forced to shut down. However, during this same period several mills increased their capacity and at least two new mills based on the tempering-degerminating system were built. All but one corn dry mill uses the tempering-degerming process for producing degermed products and about 80% of the corn dry milled for corn meal, flour, grits, and breakfast foods is degermed. The industry has been slow to adopt the dry degerming system introduced in the late 1960's by two European firms. [3]

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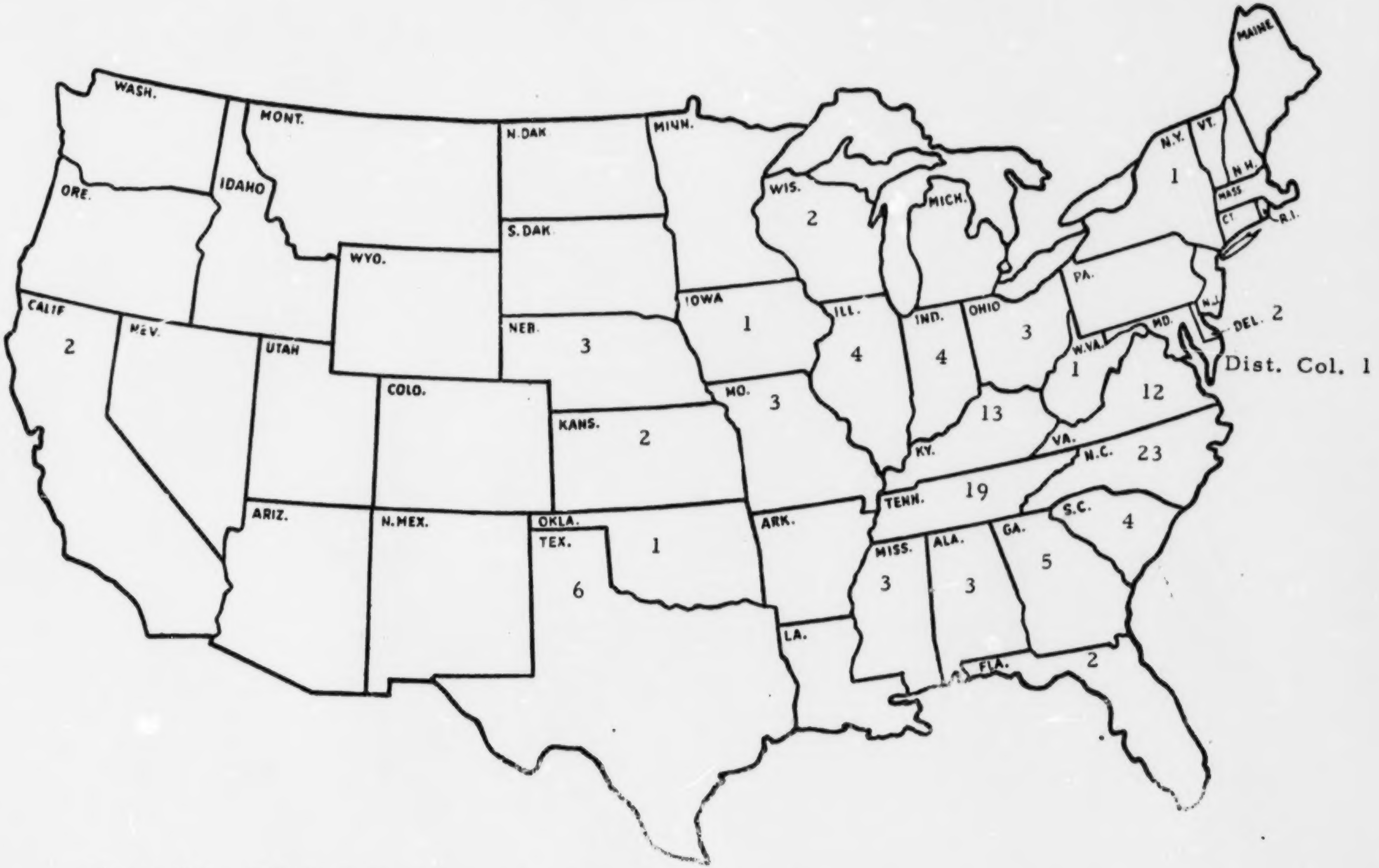
[1] "Corn Mills," The Northwestern Miller, Vol. 278, No. 9, September, 1971.

[2] "Corn Mills," The Northwestern Miller, Vol. 278, No. 9, September, 1971.

[3] Brekke, O. L., "Corn Dry Milling Industry," in Corn: Culture, Processing, Products. G.E. Inglett, editor, Westport, Conn., Avi Publishing Co. 1970.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2

Figure II-3. Distribution of corn dry milling plants among states in the U.S., 1971.
Source: Northwestern Miller, Vol. 278, No. 9, September, 1971.

Table II-10. Number and distribution of corn mills by state, 1971

State	No. Mills
Alabama	3
California	2
Delaware	2
District of Columbia	1
Florida	2
Georgia	5
Illinois	4
Indiana	4
Iowa	1
Kansas	2
Kentucky	13
Mississippi	3
Missouri	3
Nebraska	3
North Carolina	23
New York	1
Ohio	3
Oklahoma	1
Pennsylvania	4
South Carolina	4
Tennessee	19
Texas	6
Virginia	12
West Virginia	1
Wisconsin	2
Total	124

Source: Northwestern Miller, Vol. 278, No. 9, September, 1971.

Corn dry millers purchase grain competitively in commodity markets. They generally buy corn of U.S. Grade No. 2 or better, except for moisture content. In 1972, the industry utilized 139 million bushels of which 23 million bushels were converted into breakfast foods.[1] This amounts to only about 3 percent of the total domestic use of corn in the United States each year. Corn prices, therefore, are not substantially affected by corn dry miller's purchases.

Number of Plants and Employment by Segment

Employment data for 70 [2] of the 124 corn dry milling firms indicate that employment averages about 50 per mill. Employee requirements would vary according to the size of the mill. Total employment in the 70 firms was 3,300 in 1967 as indicated in Table II-11.

Selection of Segments to Total Industry

There are two basic types of corn dry mills in the United States, smaller plants that produce only ground whole corn and larger corn mills that produce a variety of products. The smaller plants dry clean grain before grinding and no process wastewaters are generated. The larger corn dry millers wash the corn prior to tempering and milling to remove surface dirt and microorganisms. During the cleaning process the moisture content of the corn increases constituting the first step in the tempering process. The spent wash water represents the bulk of the wastewater from this segment of the grain milling industry. The larger corn dry millers process 80 to 90 percent of corn dry milled in the United States. Since the smaller corn dry mills generate no wastewaters, they are not affected by water pollution abatement programs and were eliminated from this study's considerations.

Likely Impacted Segments

Corn dry mills using the tempering-degerminating process are likely to be significantly impacted by water pollution control requirements. These mills produce a high percentage of the total corn dry mill products in the United States. They tend to be the larger mills in the industry and most are located in the midwestern part of the country.

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[1] Source: Feed Situation, ERS, USDA, May 1973.

[2] Source: Census of Manufactures, U. S. Department of Commerce, 1967. Based on establishments with 75 percent or greater product specialization.

Table II-11. Selected employment, production and financial characteristics of the corn dry milling industry in the United States, 1967

Corn Mill Products	Establishments	All Employees		Production Workers			Value added by manufacture	Cost of materials	Value of shipments	Capital expenditures new
		No.	Payroll	No.	Man-hours	Wages				
	(No.)	(000's)	(million $)	(000's)	(millions)	Million dollars				
Primary product Class of establishment (90% or more spec.)	43	2.1	15.2	1.5	3.4	9.5	53.2	159.6	212.3	4.1
Establishments with 75% or more specialization (75-89% spec)	27	1.2	9.4	.9	2.0	5.8	21.4	89.8	110.7	2.2

Source: Census of Manufacturers, U. S. Department of Commerce, 1967

It is not known how many of the larger corn dry mills currently discharge into municipal treatment systems or directly into surface waters. Treatment strategy will vary from plant to plant depending upon the quantity and quality of corn processed and access to a municipal treatment system.

Corn Dry Milling Financial Profile

Published financial data on the corn dry milling industry are not available. All but a few corn dry millers are too small for company statistics to be reported in Standard and Poor's Industry Survey or Moody's Industrial Manual. Those companies large enough to be reported are conglomerate-type companies so that reported data does not accurately reflect corn dry milling financial data. To assess this industry fairly and complete the subsequent plant impact analyses procedure used was to construct a model plant situation.

Plants by Segment

Of the two basic types of corn dry mills in the United States, only the larger mills using the tempering-degerminating process are of concern in this study. The smaller plants, producing only ground whole corn, dry clean the grain before grinding and generate no process wastewaters. The larger mills using the tempering-degerminating process range in size from about 2,500 to 20,000 cwt per day capacity of meal production. A model plant of 12,000 cwt per day capacity was chosen to represent the industry. A plant this size would process 30,000 bushels of corn per day to produce 12,000 pounds of finished corn meal products and should represent the general condition of the industry.

The model plant was assumed to operate at 100 percent of capacity where 100 percent is defined as 6,240 production hours or 260 days x 24 hours per day. The level of production may exceed the 100 percent utilization standard in the milling industry so that 100 percent of capacity is not an unrealistic level of production and represents current industry experience.

Annual Profit Before Taxes

Using the model plant concept and the operating assumptions, the estimated pre-tax income and selected rates of return on investment were as reported in Table II-12. After-tax ROI was estimated as 8.8 percent and after-tax earnings on sales was 2.6 percent. These values were computed using 1967-1971 average costs of inputs and prices of products. In light of the unusual recent prices and the present unsettled market conditions, this improved the chance of reflecting "normal margins" between prices paid and prices received for corn dry milling products.

Table II-12. Estimated pre-tax income and rate of return on average invested capital and after-tax return on sales for a moderately large corn dry mill (30,000 bushels per day)

Financial Measure	Value
Pre-tax net income ($000)	843
Pre-tax ROI [*] (%)	17.0
After-tax ROI [*] (%)	8.8
After-tax return on sales (%)	2.6

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[*] Average return on fixed investment calculated by financial statement method.

Average fixed investment, on which the rates of return were calculated, was derived by dividing replacement costs by two (an estimate of average fixed assets) plus total working capital (current assets) less current liabilities (based on grain milling industry averages). The average fixed or invested capital estimate was intended to approximate invested capital in reported financial data. After-tax income was based on a 48 percent tax rate without either carry-forward or back tax provisions.

Annual Cash Flow

Estimated annual cash flow (after-tax income plus depreciation) and the ratio of cash flow to average fixed investment were as shown in Table II-13. Annual depreciation was assumed to equal 6 percent on equipment and 4 percent on buildings. Buildings were estimated to equal 70 percent of the total plant investment and equipment is equal to 30 percent of the total.

The annual cash flow of $724,000 was also 4.2 percent of sales. This is comparable to other milling industry ratios.

Market (Salvage) Value of Assets

Data concerning the salvage value of corn dry mills are generally not available. A small corn dry mill producing whole corn meal has very little value, even to another corn dry miller, because of its small size and because whole corn meal has been a declining percentage of total corn dry milling production, indicating declining demand. A large corn dry mill using the tempering-degerminating process would be of little value to anyone other than another corn dry miller. The equipment, which is universally used in the milling industry, could be sold but approximately 70 percent of the value of a mill is attributed to buildings which are potentially suited for general grain milling uses. Since the model plant was assumed to be a moderately large-sized tempering-degerminating mill, it should have value to other grain milling industry segments and was assumed to have a positive salvage value. For purposes of analysis, a salvage value of 50 percent of the estimated replacement value was used.

Capital Structure

The averaged fixed investment in a corn dry mill was estimated as $4.971 million for the moderately large-sized model plant. Sales were estimated as $17.160 million per year. This yields average sales of $3.45 for each dollar of investment. This yield is comparable to other

Table II-13. Estimated cash flow for a moderately large corn dry mill

Financial Measure	Value
Annual cash flow ($000)	724
Cash flow on average fixed investment (%)	14.6

agricultural processing industries which, in general, require a low investment per dollar of sales.

The capital requirements estimated for the model plant are presented in Table II-14. The replacement value of $6,198 million assumed a breakdown of 70 percent for buildings and 30 percent for equipment. Total annual working capital of $3,120 million was estimated to equal approximately 20 percent of total operating costs, including raw product (corn) costs.

Cost Structure

Model plant data and budgets were prepared to estimate the cost structure of representative operations.

Fixed or plant related expenses were defined as those which do not directly vary as a function of throughput. These expenses include:

- maintenance and supplies
- taxes and insurance
- plant and labor overhead
- sales, general and administrative

Additionally cost estimates were made for depreciation and interest costs. Variable or production related expenses were defined as those which will generally vary proportionately with throughput--in other words, a fixed amount per unit processed. They include:

- raw materials
- power
- water
- process supplies, chemicals, etc.
- operating labor
- plant supervision and fringe benefits.

Fixed Costs - Indirect operating costs, as shown in Table II-15, represents 7.3 of sales in the model plant. This is higher than some of the other grain milling industries and is due primarily to large selling and related costs. Corn dry millers typically spend large amounts on product promotion in retail markets trying to differentiate their relatively homogeneous products in the mind of the consumer.

Depreciation is a small percent of sales, 1.7 percent, as shown. This reflects the fixed asset capital requirements of corn dry milling which are relatively low compared to other input costs.

Table II-14. Estimated replacement value and working capital requirements for a moderately large corn dry mill

Capital Component	Requirement
	($000)
Replacement value of plant, equipment and site	6,198.6
Total working capital	3,120.0
Replacement value of total assets	9,318.6

Table II-15. Estimated costs for a moderately large dry corn mill

Item	$000	Percent
Sales	17,160	100.0
Raw materials	10,374	60.4
Direct operating costs	4,287	25.0
Indirect operating costs	1,251	7.3
Depreciation	285	1.7
Interest	120	.7
Total before-tax cost	16,317	95.1

Interest costs are shown to be equal to .7 percent of sales for the model plant.

Variable Costs - Variable costs for the corn wet milling industry are also shown in Table II-15 for two major components: raw materials (corn) and direct operating costs. Raw materials costs were estimated to be 60.4 percent of sales and are the most dominant production cost component.

Direct operating costs, representing 25 percent of sales, are the second largest cost component. While not extremely high in comparison to other grain milling industries, direct operating costs at this level indicate that dry corn milling is a moderately complicated production process.

Distribution of Model Plant Financial Data

There was no known individual plant financial data concerning corn dry milling in published sources. A variety of engineering and financial guidelines were used to construct the financial characteristics of the model plant. A summary of the corn dry mill financial characteristics plus additional values and assumptions are presented in Table II-16.

Selected financial data and ratios, such as from IRS business statistics, Dun and Bradstreet, Standard and Poors, Fortune and other Sources were used as guides and indicators of likely plant characteristics. The 1967 Census of Manufactures volume and value of shipment data was used to estimate an average mix of end products and their relative values. The result is a model of a moderately large size tempering-degerminating corn dry mill.

Because the model plant was intended to reflect 'normal' financial conditions in the industry, average cost and price data for the 1967-1971 period were used. The current unsettled market conditions and recent prices are not considered representative of normal conditions.

Ability to Finance New Investment

It was estimated that the corn dry millers' ability to finance new investment is comparable to the grain milling industry in general. No specific data are available to suggest either a better or worse ability. The financial characteristics of the grain milling industry in general were presented previously in the section on bulgur processing. Summary data are presented in Table II-8 above.

Table II-16. Summary of financial data pertaining to the corn dry milling model plants

Item	Units	Values 15,000 bu/day	 30,000 bu/day	Remarks
Utilization	%	100%	100%	260 days = 52 wks x 5 - 24 hr. days
Annual throughput	1,000 bu	3,900	7,800	260 days x 30,000 bu x 100%
Sales	$1,000	8,580	17,160	$2.20/bu. value, f.o.b., mill
Raw Product Costs	$1,000	5,187	10,374	$1.33/bu. No. 2, yellow corn, Chicago, 1967-71 ave.
Variable costs	"	2,340	4,287	77% of operating cost, excluding corn
Fixed costs	"	585	1,251	23% of operating cost, excluding corn
Cash earnings	"	468	1,248	
Depreciation	"	142.6	285	6% equipment; 4% buildings
Interest	"	60	120	.7% sales
Pre-tax income	"	265.4	843	
Net income	"	138	439	
After-tax cash flow	"	280.6	724	
Replacement costs	"	3,100	6,199	30% equipment; 70% buildings
Working capital	"	1,716	3,120	20% sales
Current liabilities	"	686.4	1,248	40% total working capital
Average Fixed Investment (AFI)	"	2,579.6	4,971	
Pre-tax income/AFI	Ratio	.103	.170	
Net income/AFI	"	.053	.088	
Cash flow/AFI	"	.109	.146	
Net income/sales	"	.016	.026	

Note: Financial data for the 30,000 bu/day plant (moderately large) are presented in the text. Data for the 15,000 bu/day plant are subsequently used in the Impact Analysis section below.

Corn Dry Milling Pricing

Prices in the corn dry milling industry involve three principal products: corn grits, corn meal and corn flour. These products comprise approximately 70 percent of the total weight of the corn milled. A small percentage of the remainder is processed into corn oil. The rest is sold as hominy feed for animals.

Mills are highly flexible and can vary the percentages of the principal products according to consumer demand. Typical yields in estimated pounds per bushel processed are shown in Table II-17 . The product mix can and does vary from day to day depending upon the quality of corn being milled, the type of milling equipment used and the product specifications sought.

Price Determination

Demand

A majority of the products of the corn dry milling industry are used for human consumption. The byproducts are utilized as livestock feed. Some products have limited uses in non-food industrial production. The primary products: Corn meal, corn grits and corn flour are used directly in home meal preparation. They are also used widely in the food processing industry as ingredients in prepared mixes and other food products. Besides being used as a food ingredient, corn flour that has been specially processed is used in industry as a binder and bonding agent. With the exception of corn oil, the fractions remaining after the removal of the primary products are mixed together and sold as hominy feed which is an ingredient with exceptional nutritional value for many types of livestock feeds.

Table II-18 shows the per capita consumption of corn dry milling primary products for the years 1950 to 1972. After many years of decline, corn meal and flour show a slight increase in per capita consumption. Prepared cereal consumption has increased over the years as consumer demand responded to the heavy use of advertising by the industry. The per capita consumption of hominy and grits has declined slightly after reaching a high point in the early 1960's.

There are two general classes of corn meal, whole corn meal and degermed corn meal. Whole corn meal is produced by grinding the whole corn kernel. The resulting meal is packaged into small, consumer sized packages. The whole corn meal may be sifted or bolted to remove

Table II-17. Corn dry milling, products by percent and weight of bushel of corn processed (degerming system) [1]

Final Products	Yield as percent of bushel processed	Estimated pounds per bushel processed
Corn grits	35.0	19.6
Corn meal	30.0	16.8
Corn flour	5.0	2.8
Hominy Feed	25.0	14.0
Corn oil	1.0	.6
Shrinkage	4.0	2.2
Total	100.0	56.0

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[1] Brekke, O. L., "Corn Dry Milling Industry," in Corn: Culture, Processing, Products. G. E. Inglett, editor, Westport, Connecticut: The Avi Publishing Co., 1970.

Table II-18. Per capita consumption of selected corn dry milling products, 1950-1971

Year	Cornmeal and flour	Hominy and grits	Prepared cereals
1950	11.8	2.6	1.5
1955	8.7	2.7	1.7
1960	6.6	4.0	1.9
1965	6.5	4.5	2.2
1966	6.9	4.4	2.2
1967	7.2	4.2	2.3
1968	7.3	4.2	2.3
1969	7.4	4.2	2.3
1970	7.4	4.2	2.3
1971	7.4	4.2	2.3

Source: National Food Situation, U.S.D.A.

particles of hull and some of the germ to improve the color and texture of the final product. Whole or bolted meal has a short shelf life because of its high fat content, large surface area, and the action of naturally occurring enzymes. Small mills located primarily in the South continue to market whole corn meal to the local trade. Because it must be consumed in a relatively short time after grinding, whole corn meal does not lend itself to large corn dry milling operations or long channels of distribution.

Degermed corn meal is produced in larger, more modern mills and has improved color and shelf life because the oil containing germ is removed before milling. Consumers prefer degermed corn meal in comparison to whole corn meal for most uses because of its improved appearance. 1/ Degermed corn meal is preferred by food processors for use in prepared mixes and as an ingredient in other foods because of its appearance and also because of its greater storage life. Table II-19 shows the amounts of both types of corn meal shipped. Although both whole corn meal and degermed corn meal are declining as percentages of total corn meal production, degermed corn meal is declining less rapidly. Most of the decline in production of degermed corn meal can be attributed to the increased production of corn flour.

The demand for corn flour has increased dramatically in the past few years as the demand for snack foods and breakfast cereals has increased. This increase in demand has shifted corn flour's role from that of a byproduct to primary product. Some dry corn millers have found it profitable at times to make 100 percent runs of corn flour at the expense of meal and grits. Corn flour that has been gelatinized is also used in non-food industrial applications such as a binder for sand cores for metal casting and as a bonding agent in pelletizing ores.

Corn grits, sometimes called hominy grits, are the largest particle size product from the corn dry milling process. When used directly as a human food they are simply cooked in boiling water until the texture has a pleasing balance of soft grittiness and smoothness. The greatest demand for corn grits has traditionally been in the South, although the use of corn grits has been increasing in other parts of the country.

As shown in Table II-19, the use of grits for direct human consumption as a percentage of total corn grit production has dropped substantially because the demand for brewer's grits and flaking grits has increased greatly in the past few years. Corn grits and flakes are used by brewer's

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1/ Brockington, S. F. "Corn Dry Milled Products" in Corn: Culture, Processing, Products. Editor, G. E. Inglett. Westport, Conn: The Avi Publishing Co., 1970, pp. 292-306.

Table II-19. Corn dry milling - shipments of products [1]

Corn Product	1958 1,000 cwt	1958 %	1963 1,000 cwt	1963 %	1967 1,000 cwt	1967 %
Corn meal for human consumption:						
Whole corn meal	4,900	31	5,042	27	6,543	25
Degermed corn meal	6,822	43	7,529	41	9,863	38
Corn flour	1,675	11	1,652	9	4,003	15
Corn meal for animal feed:	2,314	15	4,281	23	5,700	22
Total	15,711	100	18,504	100	26,109	100
Grits and hominy for human consumption:	3,976	33	12,807	54	7,454	36
Brewer's grits and flakes	8,112	67	10,813	46	13,028	64
Total	12,088	100	23,620	100	20,482	100

[1] Does not include hominy feed and other byproducts or corn oil.

Source: Bureau of the Census, Census of Manufacters, U. S. Department of Commerce, 1967.

as a source of carbohydrate. Brewer's generally specify requirements for moisture, fat content, crude carbohydrate extract, and granulation when ordering corn grits from millers. In order to increase brewing capacity, some brewers call for specially processed grit flakes with varying degrees of starch modification to increase the rate of fermentation. Flaking grits are also used in the manufacture of corn flakes and snack type ready-to-eat foods. The demand for Brewer's grits and flakes is directly influenced by the demand for the end food products and according to all indicators the increase in demand should continue.

The corn kernel contains only about 5 percent oil and it is not economically feasible to process corn just for the oil. Corn oil is a byproduct of corn dry milling and the demand for corn oil has little if any effect on the amount of corn processed. Due to the increasing awareness of the importance of polyunsaturated fatty acids in the diet, the use of corn oil in margarines and as a salad and cooking oil has increased substantially in the past few years. Because of the strong demand and relatively inflexible supply, the price of crude corn oil fluctuates erratically. Besides the special uses for corn oil, demand and price is influenced by competition from other grain and vegetable oil sources such as soybean, cottonseed, peanut, palm and safflower oils.

Hominy feed is a manufactured product which includes corn bran, corn germ from which oil has been expelled and part of the starchy portion remaining after grits, meal, and flour have been removed. It is a low protein, high energy product that is a more economical source of protein and energy than available feed grains for certain livestock operations. Hominy feed prices are regularly reported along with other feed ingredients competing in the same market. Some of the competing feedstuffs include wheat millfeeds, rice bran, alfalfa meal and feeding quality molasses.

Table II-20 summarizes the level of demand for all corn dry milling products by quantity and value of shipment as reported by the Census of Manufactures. The total value of shipments for 1967 was $270.6 million when 117 million bushels of corn were milled. In 1972 about 116 million bushels of corn were milled, a slight decrease from 1967. The total dollar value of shipments will be higher because of inflation but more important are the shifts that have occurred in product mix. When production figures become available for 1972 they will probably show the trends continuing toward corn flour and brewer's grits and away from whole corn meal and grits other than for brewer's use.

Table II-20. Quantity and value of shipments by all producers in SIC 20413: Corn Dry Milling, 1963 and 1967

Product	Total Shipments Including Interplant Transfers					
	Quantity		Value		Imputed Price per Pound	
	1963	1967	1963	1967	1963	1967
	(million pounds)		(million pounds)		(cents per pound)	
Corn Mill Products, Total[1]	-	-	201.6	270.6	-	-
Corn Products-Human Consumption						
Whole Cornmeal	504.2	654.3	22.8	36.1	.045	.055
Degermed Cornmeal	752.9	986.7	33.8	49.9	.045	.051
Corn Grits and Hominy except for Brewer's use	1,280.7	745.4	48.0	40.0	.037	.054
Corn Grits and Hominy for Brewer's use	1,081.3	1,302.8	38.5	53.1	.035	.041
Corn Flour	-	400.3	-	23.6	-	.059
Feed Products						
Cornmeal for animal feed	428.1	570.0	11.8	16.0	.027	.028
Hominy Feed and other by-products	1,396.0	1,896.0	31.4	42.2	.022	.022
Corn Oil[2]	71.0	71.0	8.6	8.8	.121	.124
Misc. Corn Mill Products	165.2	-	6.7	.9	.041	-

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[1] Adjusted to include the value of corn oil.

[2] U.S. Fats and Oils Statistics 1950-71, ERS, USDA, Statistical Bulletin No. 489.

Source: Bureau of the Census, Census of Manufacturers, U.S. Department of Commerce, 1967.

Supply

Supply of corn dry milling products in total has remained fairly constant over the past few years. Use of corn dry milling products in direct food use has declined significantly over the past twenty years but has been offset by the growing use of the products as ingredients in processed foods.

The supply of corn dry milling products is in direct relationship to the amount of corn milled by the industry. The annual volumes milled and the volumes as a percentage of the utilization of the total U.S. corn crop are shown in Table II-21. The annual volume of corn processed, although fluctuating slightly, has remained relatively constant during the 1967-1972 period. The annual volume is generally a declining percentage of the total U.S. corn crop.

Since the corn dry milling industry utilizes only a small and declining portion of the total corn supply, the availability of corn as an input does not constitute a limiting factor of production. Corn dry millers do purchase shelled corn competitively in a market largely dominated by feed manufactures and are affected by the same factors that influence the feed market.

Prices

Prices for the end products of the corn dry milling industry are determined in four basic markets: (1) the market for home use of cereal products, (2) the food processing ingredient market, (3) the fats and oils market, and (4) the livestock feed ingredient market. These separate markets are closely related because the same grains with a few exceptions, compete in all four markets. Table II-22 compares the price of corn to the prices for various end products of the corn dry milling industry. In 1972 and 1973, livestock feed demands and unusual increases in exports of U.S. grain commodities seriously disrupted livestock feed markets causing similar disruptions in the other three markets in which corn dry milling products were sold. The result was a sharp increase in the price of corn, the basic input and in the prices of the products.

Due to the present unsettled condition of the markets in which corn dry milled products are sold, the unusual recent prices, and the need for price data to assess the financial impacts of anticipated water pollution control costs, average 1967-1971 prices were developed for the model plant analysis. The estimated values used in this study are shown in Table II-23 along with the representative gross margin developed from the data.

Table II-21. Total use of corn by the corn dry milling industry 1967-1972

Year	Use, Dry Milling Mill. Bu.	Percent of Total U. S. Corn Utilization
1967	117	2.6
1968	114	2.5
1969	116	2.4
1970	119	2.6
1971	115	2.2
1972	116	2.0

Source: Feed Situation, ERS, USDA, 1967-1972

Table II-22. Corn Dry Milling - prices of input and products

	Corn No. 2 Yellow Chicago	Grits Bulk N.Y.	Meal Yellow N.Y.	Hominy Feed Chicago	Corn Oil Crude Midwest Mills
	$/bu	$/cwt	$/cwt	$/ton	¢/lb
1967-71 ave.	1.33	4.29	4.79	41.64	.156
1972 ave.	1.36	4.23	5.49	54.50	.165
1973					
Jan. 15	1.74	4.64	6.00	60.50	.178
Feb. 15	1.66	4.85	6.15	58.50	.173
Mar. 15	1.69	4.80	6.37	59.00	
April 15	1.74	5.01	6.05	54.00	
May 15	1.80	5.69	6.75	60.00	
June 15	2.12	6.40	7.45	74.00	

Source: Milling and Baking News

Table II-25. Corn dry milling, gross margin per bushel of corn processed (degermining system)

	Estimated Pounds per bu. processed	Price per pound [2]	Value per bu. Ground
Final Products			
Corn Grits	19.6	.043	.843
Corn Meal	16.8	.048	.806
Corn Flour	2.8	.056	.157
Hominy Feed	14.0	.021	.294
Corn Oil	.6	.156	.094
Shrinkage	2.2	--	--
Total	56.0		2.194
Cost of Raw Material [4]			1.330
Gross Margin			.864

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[1] Brekke, O. L., "Corn Dry Milling Industry," in Corn: Culture, Processing Products. G. E. Inglett, editor, Westport, Connecticut: The Avi Publishing Co., 1970.

[2] 1967-71 average prices. Source: Milling and Baking News, 1967-1971.

[3] Average price of corn grits and hominy for human consumption as well as brewer's use.

[4] 1967-71 average price No. 2 yellow, Chicago.

III. SIC 2044: RICE MILLING

Rough or hulled rice is milled by one of two processes: (1) conventional or regular milling (a dry process), (2) parboiled rice milling (a wet steeping process). Only the latter is of concern from the standpoint of water pollution control. The following discussion will therefore be concentrated on parboiling plants in the Industry.

Industry Segments

At the beginning of 1973, the 42 rice mills in the U.S. were operated by 36 firms. Of this total, only 6 mills included parboiling operations. Only one mill was strictly a parboiling plant and the others had mixed operations, i.e., part of the production was dry-milled and part was parboiled.

Two firms in the industry also produce precooked rice for distribution. This is a post-milling process but waste water is generated and wastes may be a problem. No further analysis of precooked rice operations is planned herein, but these operations may warrant further study.

Types of Firms

The six parboiling mills are owned and operated by six separate firms. Four of the firms are single-plant firms, and two have two mills each, although only one mill in each firm is involved in parboiling. The five parboiling mills are identified in Table III-1.

Precise estimates of mill size are not yet known, but relative to the rest of the industry, the parboiling mills are all large operations. The firms are, consequently, also considered large firms in the industry.

Regular rice mills in Arkansas and California are frequently cooperatively owned by farmers and are, thereby, integrated backward to the farm level. However, all parboiling mills but one are privately held, and rice is competitively purchased on a sealed-bid basis. Thus, the firms of concern are not integrated backward to the farm level. On the other hand, the parboiling firms tend to be integrated forward in terms of packaging sales and distributing functions to retail markets or other outlets.

Table III- 1. Listing of parboiling rice mills (and precooked rice producers) and their plant locations

Parboiling Plants and Location	Number of Total Mills Operated by Firm
Blue Ribbon Rice Mills, Inc. Box 2587 Houston, Texas 77001	1
P & S Rice Mills, Inc. Box 55040 Houston, Texas 77055	1
Comet Rice Mills, Inc. (Subsidiary of Early California Industries, Inc.) Box 1681 Houston, Texas 77001	2
Uncle Ben's, Inc. Box 1752 Houston, Texas 77001	1
Riceland Foods Box 927 Stuttgart, Arkansas 72160	2
Rice Grower Association of California 111 Sutter Street San Francisco, California 94104 Plant: Sacramento, California	1
Precooked Rice Producers	
Riviana Foods Box 2636 Houston, Texas 77001	3
Uncle Ben's, Inc. Box 1752 Houston, Texas 77001	1

Source: Rice Millers Association

Four of the six firms are involved with milling only rice products, one firm produces other limited products, and one firm produces both rice and soybean food products and associated milling by-products. The level of diversification of the firms involved in parboiling is considered limited on the basis of the above descriptions.

A general indication of the relative importance and dominance of the largest rice milling firms is shown in Table III-2 for the 4, 8, 20 and 50 largest companies as of 1967. Since that time about 18 companies (with mostly small mills) have left the industry, but the data shown are still reflective of the relative importance of the larger rice milling companies.

Types of Plants

Most plants in the rice milling industry range in capacity from 150 to 800 cwt. per hour. The parboiling operations involve plants with 500 cwt. per hour or more capacities, although only in one plant is all rice parboiled prior to milling; hence, parboiling must generally be considered in conjunction with regular milling operations.

Only seven rice mills are known to have been built in the last 15 years. All of the parboiling plants are older mills, although all but one has 'current' or modern equipment. Plant buildings are in good shape. The age of the plant, *per se*, does not indicate the level of technology employed because worn equipment is typically replaced as required with modern equipment.

Rice mills are typically located in or near the areas of rice production. Four Southern states (Texas, Louisiana, Arkansas and Mississippi) and California are the major rice producing states and they contain almost all rice mills. Parboiling plants are also concentrated with four in Texas (all in Houston), one in Arkansas (in Stuttgart), and one in California (in Sacramento).

The milling yield of head rice (efficiency) tends to be fairly uniform in the industry. One characteristic of parboiling is to improve the head rice yield somewhat with fewer broken heads because of the hardening effect of parboiling on the rice kernel. Sources have indicated that the higher head rice yield due to parboiling is sufficient to essentially offset the higher processing cost of parboiling.

Table III-2. Percent of selected statistics accounted for by the 4, 8, 20 and 50 largest companies ranked on value of shipments in Industry 2041: Flour and Other Grain Mill Products, 1967

		Percent Accounted for by Largest Companies			
	Total [1]	4	8	20	50
No. companies	438	X	X	X	X
No. establishments	541	7	12	19	27
Value of shipments	$2,457.4	30	46	70	89
All employees:					
Number (1,000)	20.5	23	36	56	76
Payroll	$142.9	27	41	61	81
Production workers:					
Number (1,000)	14.8	24	37	57	77
Man-hours	33.2	25	37	57	77
Wages	$ 95.5	30	44	65	83
Value added by manufacture	$491.3	30	54	70	87
Capital expenditures, new:					
Total	$ 26.3	19	42	68	84
Structures and additions to plant	$ 6.3	24	56	68	84
Machinery & equipment	$ 20.0	18	38	68	84
Cost of materials	$1,966.0	30	44	70	89

[1] Values in millions except as indicated

Source: Concentration Ratios in Manufacturing, Part 2, Product Class Concentration Ratios, U. S. Dept. Commerce, 1971.

Number of Plants and Employment by Segment

As indicated, only six parboiling rice mills are in operation in the rice milling industry. Also, all are considered to be large mills relative to the remainder of the industry. Consequently, only a single category of plants is required to characterize the types of plants which will be impacted by water pollution controls, i.e., large parboiling rice mills.

Secondary data indicates that employment in each parboiling mill is estimated to average between 125 and 175 employees. In 1967, based on Census of Manufactures' data, the thirteen plants associated with the four largest companies had an average employment of 139 employees per plant. Since 1967, the number of mills has continued to fall, but the average mill size has increased.

Selection of Segments to Total Industry

Parboiling rice mills represent only 14 percent of the mills in the industry, i.e., 6 out of 42 mills. In 1971/72, these mills produced 11.9 million hundredweight of parboiled rice out of a total milled volume of 86.0 million hundredweight. On a percentage basis, this represents 13.8 percent of the total volume milled. Comparison of the 13.8 percent of volume milled with the 14 percent of parboiling plants in the industry suggests that parboiling operations are only average in size. However, five of the six parboilers also produce regular milled rice which would add to the relative size of the overall plant operations.

Total industry employment is currently estimated as 4,000 employees. The estimated employment in parboiling plants is 900 or 22.5 percent of the total (est. 150 employees per plant). Hence, approximately one-fifth of the industry employment could be affected as a result of water pollution abatement programs.

Likely Impacted Segments

As noted above, all six parboiling plants are considered to belong in a single category of large mills with parboiling operations. The impacts of water pollution controls are therefore expected to be relatively comparable among all parboiling plants.

Wastewater is produced as drainage from the parboiling process and also as waste from steam production. The former wastewater contains considerable BOD, COD and dissolved solids loadings. Consequently, treatment requirements are expected to be significant for the parboiling plants.

The scope of study for the rice milling industry has been narrowed to only 6 of 42 mills which have parboiling operations. The remaining mills are conventional or regular rice mills (dry processing only) which do not require water in their milling processes.

Financial Profile

Limited financial data on regular rice milling (dry process) were found in the literature. [1/] However, no financial data on parboiled rice milling operations, per se, were found. The former data have much applicability, though, because the milling operations are similar once rough rice has been parboiled and dried prior to milling.

Parboiled rice mills are known to be large in general ranging from about 500 to 800 cwt./hour capacities. Because plant financial data were unavailable, the procedure was to synthesize a model plant situation. Only one size plant (large) is considered adequate to measure the relative water pollution control impacts on parboiled rice operations.

Plants by Segment

Only large parboiled rice mills are of concern in this study. There are 6 such mills in the U.S.--4 in Houston, Texas, 1 in Stuttgart, Arkansas, and one in Sacramento, California as previously identified. A model plant with a 500 cwt/hour capacity was chosen. This plant was on the lower end of the large-size category, and the impacts expected in this situation should be as great as expected for any larger size plant.

The model plant is said to operate at "100%" of capacity where 100% is defined as 4,000 production hours (or 250 days x 16 hrs per day). The level of production is often termed '100%' of capacity in the milling industry with the understanding that a mill may exceed the 100% utilization standard. Thus, 100% utilization is not unrealistic and it represents recent milling experiences in the industry.

[1/] Wilson, Dale W. and David Volkin, "A Plan for Integrated Rice Marketing in Louisiana," Service Report 130, Farmer Coop. Service, USDA, Feb., 1973; and Eiland, J. C. and Theo. F. Moriak, "Rice Milling Costs in the United States, 1971/72,", ERS, USDA, Mar., 1973.

Annual Profit Before Taxes

According to the model plant procedures and operating assumptions implemented, the estimated annual pre-tax income and selected rates of return on average fixed investment are as shown in Table III-3. After tax ROI is estimated as 6.0 percent and after-tax earnings on sales is 1.6 percent.

Average fixed investment, on which the above rates of return were calculated, was derived by dividing replacements costs by two (an estimate of average fixed investment) plus total working capital (current assets) minus current liabilities (based on grain milling averages). This average fixed investment value is intended to approximate invested capital in reported financial data. After tax income was based on a 48% tax rate without either carry forward or back tax provisions.

The profitability of rice mill operations has varied in the past, most often as a result of world rice market situations rather than changes in domestic market conditions. There is currently a world rice shortage and exports have increased sharply with reduced and below average carryover stocks available for future distribution.

Annual Cash flow

Estimated annual cashflow (after tax income plus depreciation) and the ratio of cash flow to average fixed investment are as shown in Table III-4 for the selected model plant. Depreciation for the mill was based on a composite discount rate of 5.9% (reported by Eiland and Moriak, see above) for both buildings and equipment. Also, buildings were estimated to equal about 40 percent of the plant investment, and equipment about 60 percent.

The annual cashflow of $466,000 is also 3.2% of sales. The percentages shown appear comparable to other milling industry ratios.

Market (Salvage) Value of Assets

Large rice mills with modern equipment would have a reasonable salvage value to other rice mill operators in the industry. Small mills would have little value, as most small millers have generally sought to consolidate operations to gain throughput economies of operation. [1]

Since this study was concerned only with larger operations, a positive salvage value was assumed. This is confirmed by industry sources, although no precise estimates were given. As a rough estimate, salvage values of about 50 percent of book value are characteristic of well-located and good condition mills.

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[1] Wilson and Volkin, op. cit. This analysis sought an integrated operation plan to improve the economic viability of rice milling in Louisiana.

Table III-3. Estimated pre-tax income and rate of return on average invested capital and after-tax return on sales for a large parboiled rice mill

Financial measure	Value
Pre-tax net income ($000)	463
Pre-tax ROI* (%)	11.6
After-tax ROI* (%)	6.0
After-tax return on sales (%)	1.6

*/ Average return on fixed investment calculated by financial statement method.

Table III-4. Estimated cash flow for a large parboiled rice mill

Financial measure	Value
Annual cash flow ($000)	466
Cash flow on average fixed investment (%)	11.7

Capital Structure - The average fixed investment in parboiled rice milling was estimated as $3.994 million for the model plant described, and sales were estimated as $14,760 million per year. This yields sales of $3.70 for each $1.00 of investment. This level is rather typical of agricultural processing industries where value added is not especially high.

The capital required to generate such a ratio for the model parboiled rice mill are as shown in Table III-5. The replacement value of $3.813 million assumes a breakdown of 60% equipment and 40% for buildings and site. Total working capital of $3.480 million is estimated to equal 25% of fixed and variable operating costs, including raw product (rough rice) costs.

As shown, working capital requirements are comparable in magnitude to the plant investment capital requirements because relatively expensive inventories of grain must be purchased and stored prior to processing, and sales may remain as accounts receivables for 30-60 days following delivery.

Cost Structure - Model plant data and budgets were prepared to estimate the cost structure of representative operations.

Fixed or plant related expenses were defined as those which do not directly vary as a function of throughput. These expenses include:

- maintenance and supplies
- taxes and insurance
- plant and labor overhead
- sales, general and administrative

Additionally cost estimates were made for depreciation and interest costs. Variable or production related expenses were defined as those which will generally vary proportionately with throughput -- in other words, a fixed amount per unit processed. They include:

- raw materials
- power
- water
- process supplies, chemicals, etc.
- operating labor
- plant supervision and fringe benefits.

Table III-5. Estimated replacement value and working capital requirements for a large parboiled rice mill

Capital component	Requirement
	($000)
Replacement value of plant, equipment & site	3,813
Total working capital	3,480
Replacement value of total assets	7,293

Fixed Costs - Indirect operating costs, as shown in Table III-6, for the budgeted parboiled rice mill represent 3.8 percent of sales. The dominance of rough rice purchase costs (75.1% of sales) accounts for this relatively low cost component. Again, this type of cost structure is common among agricultural processing industries.

Depreciation is also a small percent of sales, i.e., 1.5% of sales as shown. Accordingly, fixed asset capital requirements of rice milling, as reflected in annual depreciation estimates, are relatively low relative to other input costs.

Interest costs as estimated are equal to 1.0% of sales. The basis for the interest cost was $.076 per cwt. of rough rice milled. This cost reflects interest allowances both for fixed assets and borrowed working capital.

Variable Costs - Variable costs for rice milling are also shown in Table III-6 for two major components: raw materials (rough rice) and direct operating costs. Raw materials costs, as noted, were estimated to equal 75.1% of sales. This percentage for parboiled rice is lower than in regular rice milling, however, because processing requirements and costs are greater due to parboiling.

Direct operating costs, representing 15.4 percent of sales, are the second largest cost component of rice milling. In general, direct costs in the large-scale plant model were relatively (as well as absolutely) lower than would be the case in smaller plants. In subsequent study, further consideration was given to scale economies even among the larger mills, e.g., 500 cwt./hour and up.

Distribution of Model Plant Financial Data

The most useful individual rice milling plant financial data were limited to the two sources cited. These data were partially but not completely applicable since the studies involved only regular rice mill operations. Even so, they did serve as a basis for constructing the representative plant model for a large-scale parboiled rice mill.

Only one model plant was constructed since all parboiled rice mills are large. However, one would still like to complete some sensitivity analyses to assess critical variables in the parboiling operations. The impact analysis phase presents such analyses.

Table III-6. Estimated costs for a large parboiled rice mill

Item	$000	Percent
Sales	14,760	100.0
Raw materials	11,080	75.1
Direct operating costs	2,272	15.4
Indirect operating costs	568	3.8
Depreciation	225	1.5
Interest	152	1.0
Total before-tax cost	14,297	96.9

To further illustrate the financial characteristics pertaining to the parboiled rice milling model plant, a summary of key financial data are as shown in Table III-7.

The Rice Millers Association, an industry association, represents most rice millers, especially in the Southern states. This Association was quite cooperative in supplying general industry information for this study to the extent possible. Two limitations were: (1) the association does not collect or analyze financial data of individual plants, and (2) disclosure guidelines prohibit release of individual plant production and distribution reports. Aggregate production and distribution data are published by the association and this information is publicly available.

Under the time constraints of this study it has not yet been possible to verify the production and financial data presented for the model plant. Wherever data were missing, it was necessary to make personal judgments and approximations. A variety of selected financial data and ratios, such as from IRS business statistics, Dun & Bradstreet, Fortune and other sources were used as guides and indicators of likely plant characteristics. Census of Manufactures reports (of SIC 2044 in particular) were also helpful.

Because the model plant is intended to reflect 'normal' financial conditions in the industry, average cost and price data (prices for 1968-71) were used. This was especially critical in that only very recently have rice prices increased dramatically to record highs in face of world rice supply shortages. Current and/or near term market conditions are simply not considered representative of normal conditions.

Table III-7. Summary of financial data pertaining to the parboiled rice milling model plant

Item	Units	Value	Remarks
Utilization	%	100%	250 days x 16 hrs = 100%
Annual throughput	1,000 cwt.	2,000	Rough rice milled basis
Sales	$1,000	14,760	$7.38/cwt. est. value (rough)
Raw product costs	"	11,080	$5.54/cwt. f.o.b. mill
Variable costs	"	2,272	80% operating cost excl. r. ric
Fixed costs	"	568	20% operating cost excl. r. ric
Cash earnings	"	840	
Depreciation	"	225	5.9% replacement cost
Interest	"	152	$.076 per cwt.
Pre-tax income	"	463	
After tax cash flow	"	466	
Net income	"	241	
Replacement cost	"	3,813	
Working capital	"	3,480	25% operating costs
Current liabilities	"	1,392	40% total working capital
Ave.-fixed investment (AFI)	"	3,994	
Pre-tax income/AFI	Ratio	.1159	
Net income/AFI	"	.0603	
Cash flow/AFI	"	.1167	
Net income/sales	"	.0163	

Ability to Finance New Investment

General requirements for financing new investment were set forth in the earlier section on bulgur, along with general financial data for the milling industry in general (see Table II-8).

The only financial data currently available on rice milling plants is in a study entitled, A Plan for Integrated Rice Marketing in Louisiana. [1] The report analyzes six mills, with no company identification, and presents condensed operating statements and balance sheets. Data are for 1969, 1970 and 1971 and permit an evaluation of the financial structure and strength of this particular group of mills. Since these mills are not engaged in parboiling, they are not strictly comparable to mills which would be impacted by pollution control requirements.

The combined mills had net sales of $35.7 million to $41.7 million during each of the three years, 1969-1971. The gross margin on sales ranged from 12.9 percent in 1970 to 14.8 percent in 1969. Three of the six mills lost money in 1969, with the composite loss amounting to $79,000. Four mills showed losses in 1970 with a composite loss of $195,000. All six showed a pre-tax profit in 1971 totalling $485,000 or 1.2 percent on sales. Because of prior years' losses, after-tax income is unknown.

The six mills had a total investment of $7.1 million at the end of 1971, with $4.4 million in net worth. Total debt amounted to $2.7 million or 61 percent of net worth. Long-term debt was only 7 percent of net worth, an extremely low ratio in comparison to other manufacturing industries. The $485,000 before-tax profit in 1971 amounted to 11 percent of net worth.

In terms of cash flow, the mills reported $342,000 to $371,000 in depreciation, or 4.4 to 5.3 percent of total assets. If the 1971 level of profits can be maintained, the mills will be in a relatively strong cash flow position. Continued profits combined with the extremely low debt situation, would place these mills in an excellent position to finance new investment.

It must be recognized, however, that the 1971 turn-around in operations from losses to profitability does not constitute a trend. Obviously, if operating losses reoccur in the near future, this group of mills could not finance new investment. Data are not available for these mills for 1972, but the strength of world rice prices and U. S. exports indicate that the industry should be in a stronger position than in 1971.

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[1] Dale W. Wilson and David Volkin, A Plan for Integrated Rice Marketing in Louisiana, Farmer Cooperative Service, USDA, Service Report No. 130, February, 1973.

As noted previously, these six mills are not strictly comparable to mills which parboil rice. The value of any comparison depends upon the relative financial condition of other mills. It seems reasonable to assume that the parboiling mills are larger and more profitable than the six Louisiana mills. They are better located for export markets. If they are earning at or above the level of the six mills in 1971, they should have no difficulty in financing new investment for pollution abatement. Internally generated funds (net profits and depreciation) and borrowing capability would appear adequate. Since no financial data are available on the other firms, however, any conclusions as to financial condition remains pure conjecture. Under the study time limitations, no valid estimate of ability to finance new investment was possible.

Pricing

Price determination and expected price changes in the rice milling industry are related first to various end products and byproducts of rice milling and their respective markets. As illustrated in Figure III-1, the main milled rice components are hulls, head rice, brokens (second heads, screenings and brewers), bran and polish. A growing export demand for brown rice (dehulled only) also exists. Each component of total supply may be influenced differently in its respective markets given a change in supply of total milled rice (and associated byproducts).

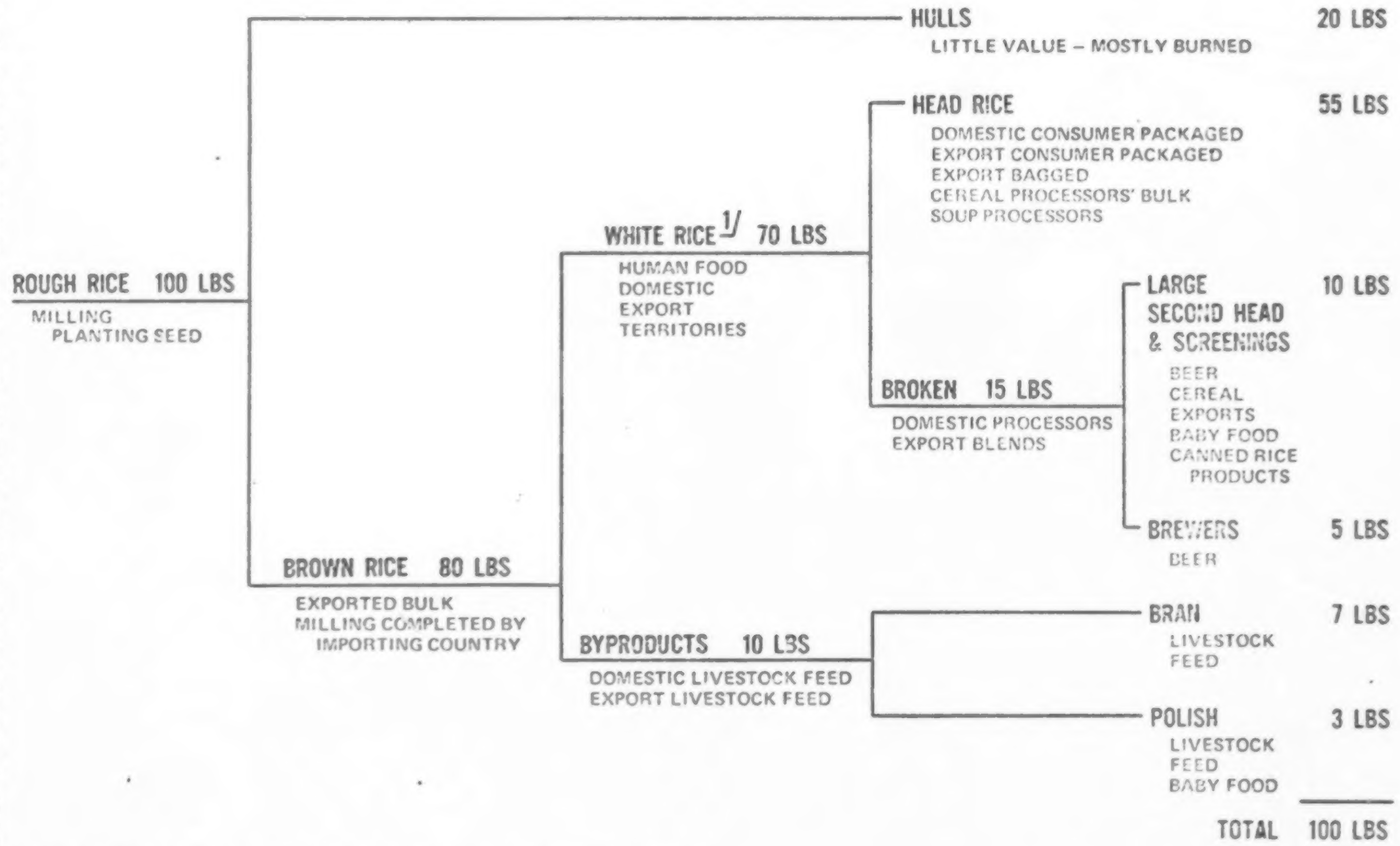
Price Determination

Both demand and supply conditions are summarized below to gain an understanding of how prices are determined for rice.

Demand

In recent years total shipments of U.S. milled rice (excluding only hulls, bran and polish) have been broadly: 60 percent to exports and 40 percent to domestic trade. Foreign markets are quite important in rice marketing as suggested by the high proportion of export shipments. A major factor in the export market has been that approximately two-thirds of total exports have been financed under Title I of P.L. 480. The balance has been dollar exports including shipments to U.S. territories. In addition, until recently (December, 1972), export sales were elgible for export payments equal to the difference between U.S. and world prices for rice. Since December, 1972, world prices have risen above U.S. prices (due to world supply shortages in general) and export payments have been discontinued until further notice.

Figure III- I. **RICE MILLING PROCESS, APPROXIMATE PRODUCT PROPORTIONS, AND MAIN USES**


ROUGH RICE 100 LBS
MILLING
PLANTING SEED
BROWN RICE 80 LBS
EXPORTED BULK
MILLING COMPLETED BY IMPORTING COUNTRY
HULLS 20 LBS
LITTLE VALUE – MOSTLY BURNED
WHITE RICE 1/ 70 LBS
HUMAN FOOD
DOMESTIC
EXPORT
TERRITORIES
BYPRODUCTS 10 LBS
DOMESTIC LIVESTOCK FEED
EXPORT LIVESTOCK FEED
HEAD RICE 55 LBS
DOMESTIC CONSUMER PACKAGED
EXPORT CONSUMER PACKAGED
EXPORT BAGGED
CEREAL PROCESSORS' BULK
SOUP PROCESSORS
BROKEN 15 LBS
DOMESTIC PROCESSORS
EXPORT BLENDS
LARGE SECOND HEAD & SCREENINGS 10 LBS
BEER
CEREAL
EXPORTS
BABY FOOD
CANNED RICE PRODUCTS
BREWERS 5 LBS
BEER
BRAN 7 LBS
LIVESTOCK FEED
POLISH 3 LBS
LIVESTOCK
FEED
BABY FOOD
TOTAL 100 LBS

1/ WHITE RICE IS COMMONLY REFERRED TO AS TOTAL MILLED PRODUCT.

A characteristic of the export demand for U.S. rice is that it is an elastic demand (-1.57), whereas, in contrast, the domestic demand is inelastic (-.14 in 1970). [1] Under these conditions it is generally desirable for U.S. producers and millers to export any increases in supply. Any increase in domestic supplies would result in lower returns to the industry.

U.S. milled rice exports have been shipped to numerous countries throughout the world. Since 1970, major markets have included South Vietnam, Korea, Indonesia, EEC, and South Africa. Most exported rice is either long grain or medium grain; and, further, almost a third of the exports in recent years was specialty rice, i.e., parboiled, precooked, brown and flavored rice.

Rice distribution within the U.S. involves three broad use categories: (1) direct food use, (2) processed food use, and (3) use by brewers. Rice millers distribute the bulk of the rice, but repackagers (17 in 1971) and government agencies are also involved in marketing and distribution of rice for use by the civilian population within the United States. A summary of the amount distributed by use and distributor for the 1969-70 marketing year (the most recent data available) was as follows (see Table III-8).

Most of the rice distributed to food processors was shipped directly from mills and thus mills are the dominant distributors of milled rice within the U.S.

Within the processed food use category, the types of main products processed are (1) cereal - 10.2%, (2) soup - 1.0%, (3) babyfood - 0.7%, (4) package mixes - 1.4%, and (5) other - 1.2%. (The percentages apply to the 1969-70 marketing year and total to 14.5% as indicated above.)

Byproducts of the rice milling industry include rice bran, rice polish, and hulls. They are most often sold as rice millfeed which consists of all byproducts from rice milling combined in the proportions produced, normally 61% hulls, 35% bran, and 4% polish. Rice bran is also sold separately for use as a livestock feed ingredient, as a source of vitamins by the pharmaceutical industry, or as a source of extractible oil. Rice polish is used by the food industry in preparation of infant foods and special dietary foods. Rice hulls have few uses other than as a livestock feed ingredient. Nearly half of the hulls resulting from rice milling are not used and represent a disposal problem for the industry.

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[1] Grant, W. R. and D. S. Moore, Alternative Government Rice Programs, An Economic Evaluation, ERS, USDA, AER No. 187, June 1970.

Table III-8. Distribution of rice within the U.S. by major use and distributor, 1969-70

Use and Distributor	Amount 1,000 cwt	 Percent
Direct food	13,012.8	63.1
Mills	10,538.7	51.1
Repackagers	1,643.1	8.0
Government	831.0	4.0
Processed food	2,994.9	14.5
Mills and repackagers	"	"
Beer	4,631.2	22.4
Mills	"	"
Total	20,638.9	100.0

Source: Eiland, J.C. and Theo. F. Moriak, Distribution Patterns for U.S. Rice, 1969-70, USDA, ERS-484, May 1972.

The total demand (both domestic and export) for parboiled rice has been increasing in recent years. In 1971-72, about 73 percent of all parboiled rice was exported. This percentage is greater than the percent of all rice exported which reflects an increasing preference for parboiled rice in export markets. A summary of the relative importance of parboiled rice in both domestic and export markets is shown in Table III-9 . These data represent shipments of milled rice from all southern states in 1971-72.

Also shown in Table III-9 are brown rice and regular milled rice shipments. The export demand for brown rice is also growing due to the availability of mills in the importing counties plus the general waiver of import taxes or levees on brown rice which favors final milling in the importing country.

Supply

The supply of rice produced in the U.S. is largely controlled via an acreage allotment and price support rice program administered by the USDA. Under this program rice growers are limited to an annually specified acreage which in aggregate effectively controls production. In conjunction with the allotments, prices are indirectly supported through establishment of a Commodity Credit Corporation support price and loan rate program. Rice producers may place part or all of their crop under loan with the subsequent option to either redeem the loan (given rice prices above the support level) or make actual deliveries to CCC and receive the full support price.

For the 1970-72 period, total acreage allotments in the U.S. were about 1.8 million acres and the national average support price has ranged from $4.86 to $5.27 per cwt. Because of a growing world shortage of rice, the U.S. acreage allotment was increased in 1973 by 10 percent to about 2.0 million acres. Also, the 1973 support price (based on 65% of parity) is expected to average $5.63 per cwt.

Rice production in the United States is heavily concentrated in four southern states (Arkansas, Louisiana, Mississippi and Texas) and in California. Reported harvested acreage and production of rough rice by major states is shown for 1971 and 1972 in Table III-10 Also shown is the percentage of total production in each state.

The percentage production of rice by class for the 1969-72 period has averaged as follows:

Class	Percent of Production
Long grain	50.3
Medium grain	39.5
Short grain	10.2
Total U.S.	100.0

Table III-9. Percentage distribution of shipments of brown rice, parboiled rice and regular milled rice from Southern States, 1971-72

Type	Percent of Total Shipments	Domestic-Export Percent		
		Domestic	Export	Total
Brown Rice	16.0	0.7	99.3	100.0
Parboiled Rice				
Brown	4.0	1.3	98.7	100.0
Regular	13.9	27.4	72.6	100.0
Regular Milled Rice	66.1	44.6	55.4	100.0
Total 1/	100.0	33.4	66.6	100.0

1/ Total volume shipped in 1971-72 was 52,189,379 cwt.

Source: Statistical Statement, Rice Millers Association, July, 1972.

Table III-10. Rough rice production and harvested acreages, by States, 1971 and 1972

State	Harvested acreage		Production			
	1971	1972 1/	1971		1972 1/	
	--1,000 acres--		1,000 cwt	% of total	1,000 cwt.	% of total
Southern States						
Arkansas	441	441	22,271	25.9	21,939	25.8
Louisiana	522	522	19,836	23.1	19,967	23.4
Mississippi	51	51	2,346	2.7	2,325	2.7
Texas	468	468	23,868	27.8	22,122	25.9
Missouri	5	5	235	.3	218	.3
Total Southern	1,487	1,487	68,556	79.8	66,571	78.1
California	331	331	17,212	20.1	18,583	21.8
Total United States 2/	1,818	1,818	85,768		85,154	

1/ Preliminary

2/ Total U. S. acreage and production reported by SRS. Excludes acreage and production in minor Southern States.

Source: Rice Situation, ERS, USDA, March, 1973.

There is considerable variation among states, however, in the percent of each class of rice produced. The 1969-72 average percentages of each class of rice by state are as shown in Table III-11 . Texas and Arkansas produce the major portions of long grain rice; Louisiana and California are the major producers of medium grain rice, and California is almost solely responsible for the production of short grain rice.

The supply and distribution of milled rice in the U.S. since 1965 is as shown in Table III-12 . The main use of milled rice is for exports, ranging from 56.5 to 61.4 percent of the total supply for the periods shown. Civilian consumption is the next largest use-category which accounted for 21.3 to 25.8 percent of the annual supplies (civilian consumption on a per capita basis was 7.0 pounds in 1971, but it has ranged from 6.7 to 7.7 pounds in recent years). Other distribution outlets for milled rice on a percentage basis are also shown.

Prices

Approximately 60 percent of the rice produced in the United States is exported. The price of exported rice is therefore directly influenced by the world import demand for rice, which is elastic. Until December 21, 1972 the world price of rice was lower than the United States domestic price; however, U.S. rice exporters were compensated (via an export payment) for the price differential. For example, in 1969 the U.S. export payment was $.93 per cwt. for long grain rice. In 1970 the payment was $1.21 per cwt and in 1971, $2.35 per cwt. Late in 1972 the world price of rice moved up sharply due to the normal 2.5% annual growth in consumption, adverse weather in major rice producing countries, and disruptions from military conflicts. This condition of tight supply will continue into 1974, creating a favorable atmosphere for the export sales of the increased 1973 milled rice production. [1/]

The larger U.S. rice millers often negotiate their own export sales directly with the importing nations. The medium sized and small rice millers generally sell to established internal exporters, such as Continental Grain Company or Connell Rice and Sugar Company, who then perform the exporting functions.

[1/] Rice Situation, ERS, USDA, March, 1973.

Table III-11. Percent of rice production by class by state, 1969-72 averages

State	Percent by Class of Rice		
	Long grain	Medium grain	Short grain
Arkansas	38.0	16.7	2.6
Louisiana	12.7	43.6	--
Mississippi	5.5	0.1	--
Texas	43.5	8.7	--
Minor States	.3	.2	0.1
California	--	30.7	97.3
Total	100.0	100.0	100.0

Source: Rice Situation, USDA, ERS, March 1973

Table III-12. Supply and distribution of milled rice, United States, average 1965-70, 1970 and 1971.

Item	Year beginning August			Percent of total supply		
	Average 1965-70	1970	1971	Average 1965-70	1970	1971
Beginning carryover	2,190	2,328	2,752	3.5	4.0	4.1
Mill production	59,644	56,870	64,148	96.0	94.3	94.7
Imports	287	1,064	803	.5	1.7	1.2
Supply	62,121	60,262	67,703	100.0	100.0	100.0
Food						
Shipments to territories	2,867	2,630	3,962	4.6	4.4	5.8
Used by military	159	227	183	.3	.4	.3
Civilian consumption	14,917	15,557	14,433	24.0	25.8	21.3
Total food	17,943	18,414	18,578	28.9	30.6	27.4
Used by brewers	4,246	5,000	5,407	6.8	8.3	8.0
Exports	37,616	34,096	41,522	60.6	56.5	61.4
Total disappearance	59,805	57,510	65,507	96.3	95.4	96.8
Ending carryover	2,316	2,752	2,196	3.7	4.6	3.2

Source: Rice Situation, ERS, USDA, March, 1973.

The domestic demand for milled rice is inelastic but total demand is also affected by the prices of substitute foods such as potatoes, dry beans and peas, macaroni and other cereal products. Although rice is considered a staple food item in the United States, it is not a staple in the same sense as in Asia or other countries around the world. Per capita consumption of milled rice in the United States declined 9 percent in 1972 to 7 pounds per person. This still represents an upward trend, however, from 1960, 6.1 lbs/person, and 1970, 6.7 lbs/person.

The larger rice mills generally have the necessary facilities to package milled rice in consumer sized packages. Most package their own labeled brands and distribute both regionally and throughout the United States. The larger mills also package under various private labels for wholesale and retail sale.

The medium and small rice millers tend to export most of their milled rice production or sell to repackagers to avoid the high cost of packaging.

The rest of the products of rice milling are treated virtually as byproducts. Large second heads and screenings are generally sold to food processors. Brewers rice is a grade of smaller broken rice used in making beer. Bran, polish and hulls must compete as a millfeed. No attempt was made to review price trends of all rice milling products and byproducts. However, estimated values for all products f.o.b. mills, as used for the model plant are as shown in Table III-13. These are estimated 1968-72 averages. Also shown are the average percentage yields of end products from rice milling (parboiled, which has a higher head rice yield). As previously mentioned, brown rice is also produced, primarily for export. However, no allowance for this was included in the plant analysis.

As a final overview summary of general conditions now prevailing in the U.S. rice industry, Figure III-2 is noted. This shows average rough rice prices received by farmers since 1965/66. Since the fall of 1972 a dramatic change in prices occurred. The reasons were explained above. Similar price changes have occurred from the farm to the consumer level.

Table III-13. Rice Milling. Gross margin on parboiled rice

	Percent breakdown			Estimated values	
Product	Initial	Intermediate	Final[2]	Derived value per pound[1]	Per cwt Rough rice
Hulls	20	20	20	.0036[4]	.07
Brown Rice	80				
White rice		70			
Head			60[3]	.1095	6.57
Broken					
Large second head and screenings			7[3]	.058	.41
Brewers			3[3]	.047	.14
Byproducts		10			
Bran			7	.019	.13
Polish			3	.019[5]	.06
	100	100	100		
Total sales (estimated value per cwt. rough rice milled)					7.38
Cost of raw materials plus freight cost[6]					5.54
Gross Margin					1.84

---

[1] Values are estimated f.o.b. mill averages for 1968-72

[2] End products

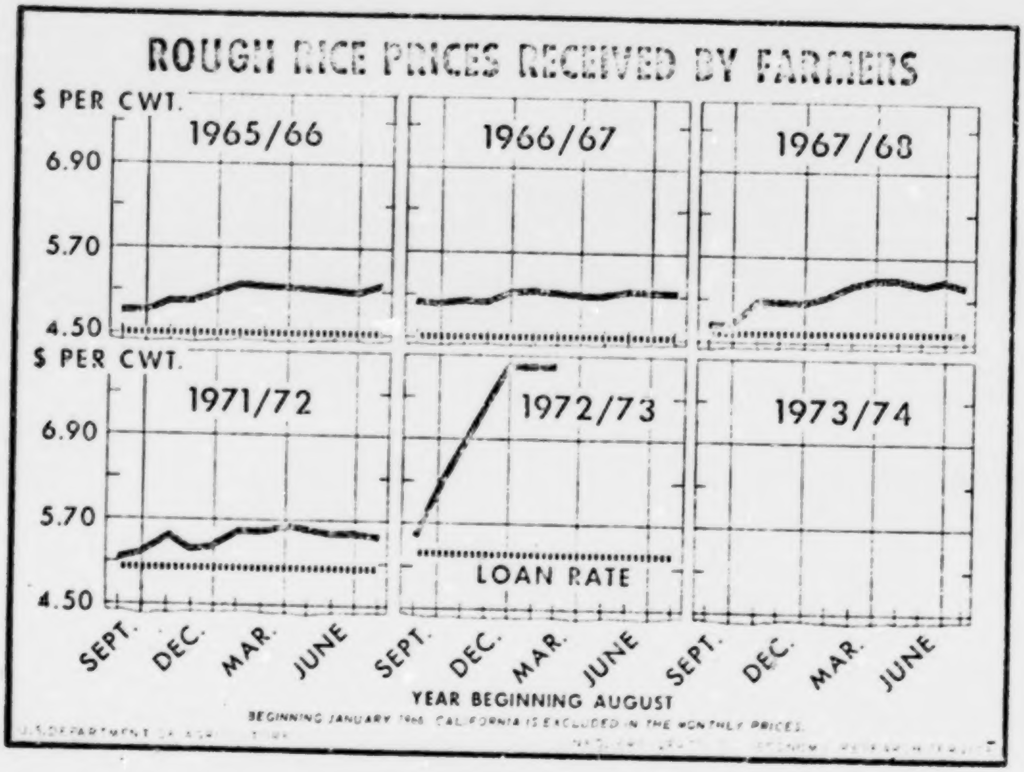
[3] Estimated milling averages for parboiled rice. Head rice percentage is higher than regular milled rice due to decreased breakage of the harder parboiled rice. Normal rice milling percentages are 55% head, 10% large second head and screenings, and 5% brewers.

[4] Price of hulls imputed from price of rice millfeed. Millfeed composition is 61% hulls, 35% bran, and 4% polish.

[5] Polish price assumed equal to bran price

[6] Based on 1968-72 average price of rough rice of $5.42 per cwt. plus $.12 cwt. freight cost for rough rice as estimated by Eiland, J.C. and T. F. Moriak, "Rice Milling Costs in the United States, 1971/72", ERS, USDA, March, 1973.

Figure III-2


ROUGH RICE PRICES RECEIVED BY FARMERS
$ PER CWT.
1965/66
1966/67
1967/68
6.90
5.70
4.50
$ PER CWT.
1971/72
1972/73
1973/74
6.90
5.70
4.50
LOAN RATE
SEPT.
DEC.
MAR.
JUNE
SEPT.
DEC.
MAR.
JUNE
SEPT.
DEC.
MAR.
JUNE
YEAR BEGINNING AUGUST
BEGINNING JANUARY 1966 CALIFORNIA IS EXCLUDED IN THE MONTHLY PRICES.

IV. SIC2046: WET CORN MILLING

The corn wet milling industry is principally made up of firms engaged in milling and refining corn (or milo) by the wet process. This study is limited to those firms. Establishments which manufacture starch from other sources (wheat, potatoes, etc.) which are included in SIC2046 have been excluded from this analysis.

Industry Segments

Currently there are seventeen plants operated by twelve companies in the corn wet milling industry. There is a wide range in the size of operations among plants and a broad range of final products produced. However, all plants have wastewater emissions and none can, therefore, be excluded from this study.

Types of Firms

A listing of the twelve companies or firms in the corn wet milling industry is as shown in Table IV-1. Three firms, i.e., CPC International, A.E. Staley Manufacturing and Clinton Corn Processing (a Division of Standard Brands) are dominant firms in the industry. Other major producers are American Maize-Products, Anheuser-Busch, Hubinger, National Starch and Chemical and Penick and Ford. Most of the major firms have diversified operations primarily involving other food and kindred products.

On an industry wide basis, the corn wet-millers produce over 500 end-use products, ranging from corn starch to antibiotics which are made from steepwater concentrate. The product mix is varied among companies dependent on product finishing department configurations within each plant.

Table IV-1. Listing of corn wet milling firms and plant locations, 1973

American Maize-Products Company
250 Park Avenue
New York, New York 10017
Plant: Hammond, Indiana 46326

Anheuser-Busch, Inc.
P.O. Box 1810 Bechtold Station
St. Louis, Missouri 63118
Plant: Lafayette, Indiana 47902

Cargill, Incorporated
Cargill Building
Minneapolis, Minnesota 55402
Plant: Cedar Rapids, Iowa 52401
Dayton, Ohio 45400

Clinton Corn Processing Company
(A Division of Standard Brands Inc.)
Clinton, Iowa 52732

Corn Sweeteners, Inc.
P.O. Box 1445
Cedar Rapids, Iowa 52406
Plant: Cedar Rapids, Iowa 52404

CPC International Inc.
International Plaza
Englewood Cliffs, New Jersey 07632
Plants: Argo, Illinois 60501
Pekin, Illinois 61555
North Kansas City, Missouri 64116
Corpus Christi, Texas 78408

The Hubinger Company
Keokuk, Iowa 52632
Plant: Keokuk, Iowa 52632

National Starch and Chemical Corp.
750 Third Avenue
New York, New York 10017
Plant: Indianapolis, Indiana 46206

Penick and Ford, Limited
(A subsidiary of VWR United Corp.)
Cedar Rapids, Iowa 52406
Plant: Cedar Rapids, Iowa 52406

A.E. Staley Manufacturing Company
Decatur, Illinois 62525
Plants: Decatur, Illinois 62525
Morrisville, Penn. 19067

Grain Processing Corp.
Muscatine, Iowa
Plant: Muscatine, Iowa

Dimmitt Corn Division
Amstar Corporation
Dimmitt, Texas 79027
Plant: Dimmitt, Texas 79027

Source: Corn Refiners Association

The major products produced by the corn wet millers are categorized as follows:

- Corn Starch
  - Regular
  - Modified
  - Dextrin
- Corn Syrup
  - Regular
  - Carbon treated
  - Ion exchange treated
- Corn Sugar
  - Dextrose
  - Sugar solids
- Lactic acids
- Enzymes
- Alcohol
- Distilled grains
- Corn Oil
  - Expeller
  - Extracted
- Corn gluten feed and meal
- Corn germ
- Cake meal
- Steepwater Concentrate
- Vitamins
- Antibiotics
- Chemical manufacture

Types of Plants

Table IV-1 also shows the seventeen plant locations of the twelve corn wet milling firms. A summary of plant locations by state is as follows:

No. Plants	State
6	Iowa
3	Indiana
3	Illinois
1	Missouri
2	Texas
1	Pennsylvania
1	Ohio
17	

As indicated, most corn wet mills are located in the Midwest. The sizes of plants range from 15,000 to 115,000 bushels capacity per day. Most individual plant capacities are not generally known.

Nine of the operating mills were built in the early part of the century and have an average age of more than 60 years. One (1) mill was built in the late 1940's, one in the early 1950's and six were built in the 1960's. The older plants are the largest and they comprise over 77 percent of the total capacity in the industry.

The level of plant technology changes constantly as machinery and equipment are replaced. New capital expenditures in the industry were reported as $18.1 million in 1958, $26.1 million in 1963, and $40.5 million in 1967. In 1967, $30.8 million of the total capital expenditures was for machinery and equipment, and $9.7 million was for structures and additions to plants. Hence, substantial improvements and modernization of plants are generally indicated.

Corn wet millers are not integrated backward to the farm level. Grain corn (No. 3 Grade or better) is purchased competitively in commodity markets by the millers. In total, corn wet millers purchase about 5% of the U.S. corn crop each year for processing. As such, corn prices are determined principally by other factors (e.g. livestock feed demand and corn supply levels) rather than being materially affected by corn wet milling demands. In 1972, the corn wet millers processed a total of about 250,000,000 bushels of corn.

Number of Plants and Employment by Segment

It is anticipated that differential economic impacts of water pollution control might occur among various plants on the basis of size of operation. For this reason, three size classes are tentatively proposed:

Bushels Capacity/Day	Class
15,000 - 50,000	Small
51,000 - 80,000	Medium
81,000 - 115,000	Large

Depending upon the availability of data, analyses of economic impacts were made for each size class of plants.

Total employment in the wet corn milling industry (SIC 2046) was estimated as 14,100 in 1967 and 13,500 in 1970 by the Census of Manufactures. A further indication of employment by individual establishments is shown in Table IV-2. These data are for 1967 and, as shown, a total of 45 establishments is indicated. Industry sources indicate that the smaller establishments

Table IV-2. Number of establishments by size. SIC2046: Wet Corn Milling

Size Class by Number of Employees	Industry 2046	
	Number of establishments	Percent of total
1-4	9	20.0
5-9	4	8.9
10-19	9	20.0
20-49	4	8.9
50-99	5	11.1
100-249	2	4.5
250-499	1	2.2
500-999	5	11.1
1,000-2,499	5	11.1
2,500 or more	1	2.2
Total	45	100.0

Source: Bureau of the Census, Census of Manufacturers, 1967, U.S. Department of Commerce.

shown are primarily wheat starch and potato starch operations which are included in SIC 2046. Actual corn wet millers would typically have more than fifty employees.

Selection of Segments to Total Industry

All corn wet millers are proposed for inclusion in a representative segment (small, medium or large) of the industry. Water pollution control is a concern for all corn wet milling operations.

It is noted again, however, that a portion of SIC 2046 is excluded from this initial study. In particular, wheat starch and potato starch plants are excluded because of their limited operations. For example, it is estimated that over 93 percent of the total U.S. production of starch comes from corn. The relatively small balance is produced by wheat and potato starch operators. Wheat starch plants utilize low grade wheat flour (clears) in their plants to produce both starch and gluten. Potato starch plants utilize low grade or cull potatoes and often these plants only operate seasonally when cull potatoes are available.

Likely Impacted Segments

Each size class of the corn wet milling industry was significantly impacted due to increased expenditures for water pollution control. While there may be economies of scale in treatment costs for large mills, it is noted that the largest corn wet mills are also the oldest. Both additional land and building space are problems for these plants; thus, the largest mills may have offsetting factors which would increase their per unit treatment costs.

Among the seventeen corn wet milling plants, twelve currently discharge into municipal treatment works. The five remaining plants discharge directly into surface water receptors. The treatment strategy to be developed may differ substantially among plants with and without tie-in to a municipal treatment system.

Financial Profile

Financial data for the corn wet milling (or, also, corn refining) industry are essentially limited to selected company statistics such as reported in Standard and Poor's Industry Survey and Moody's Industrial Manual. (See section "Ability to Finance New Investment" below for a summary of key financial ratios for four main companies in corn wet milling.) Further, corporate annual reports were screened with only partial success in isolating corn refining division statistics of the corporations in the industry. In general, corn refiners are conglomerate-type companies whose reported data may not accurately reflect corn refining financial data. Except for one case, no individual plant financial data or studies were found. In order to complete the type of plant impact analyses planned and to relate the financial characteristics of the industry as fairly as possible, representative model plants were constructed. Time was available to complete only one such model plant for this report.

Plants by Segment

Corn wet milling plants, essentially refineries, are complex and very capital intensive in structure. After corn is milled to produce basic starch, starch finishing and refining is continued to produce many possible products. The most common products derived from starch are corn syrup and corn sugar (dextrose), plus, of course, starch itself (including modified starches such as dextrin). However, further processing of each of these products is completed in many plants.

Each plant in the industry is considered unique beyond the starch (or starch slurry) production stage, but all are believed to produce some starch (including dextrin), corn syrup and corn sugar. By-products of corn oil, corn gluten feed and meal, and steepwater concentrate are also normally produced. A 'basic' model plant reflected these major products. The proportions of each product were assumed to be the same as was reported for the industry as a whole by the Census of Manufactures in 1967 (the latest reported shipment data).

Attention was given to the synthesis of a 'medium' (60,000 bushels) per day capacity) plant model. This size of plant falls well within the three proposed size categories of the industry which have been defined as follows:

Bushels Capacity/Day	Class
15,000 - 50,000	Small
51,000 - 80,000	Medium
81,000 -115,000	Large

In subsequent study the 60,000 bu. per day plant was scaled up to 90,000 bu. per day to assess the impact of water pollution controls on a large plant and scaled down to 30,000 bu. per day to consider the impact upon a small plant. Only the 'medium' sized plant is described in this section, although comparative data for three plant sizes are presented in Table IV-7 below.

Annual Profit Before Taxes

Based on the selected financial data reported below, net profit as a percent of sales ranged from 2.7 to 4.9 in 1970 and from 1.6 to 3.8 in 1971 for four corn refiners. These data are probably indicative of corn refining profits even though the data are for the companies' total operations.

According to the model plant concept, procedures, and operating assumptions implemented, the estimated pre-tax income and selected rates of return on investment are as reported in Table IV-3. After-tax ROI is estimated as 5.1 percent and after-tax earnings on sales is 3.7 percent. The latter value is comparable to those reported above for the four companies in 1970 and 1971.

One qualification of the model plant data is that costs and prices of products were estimated 1967-1971 averages in order to improve the chance of reflecting normal 'margins' between prices paid and prices received for corn wet milling products.

Average fixed investment, on which the rates of return were calculated, was derived by dividing replacement costs by two (an estimate of average fixed assets) plus total working capital (current assets) less current liabilities (based on grain milling industry averages). The average fixed or invested capital estimate approximated invested capital in reported-financial data. After-tax income was based on a 48 percent tax rate without either carry-forward or back tax provisions.

Annual Cashflow

Estimated annual cashflow (after-tax income plus depreciation) and the ratio of cash flow to average fixed investment are as shown in Table IV-4 for the selected corn wet mill model plant. Annual depreciation is assumed to equal 5 percent on equipment and 4 percent on buildings. Also, equipment is estimated as equal to 75 percent of the total plant investment and buildings as equal to 25 percent of the total. (Note the capital intensive ratio.)

Table IV-3. Estimated pre-tax net income and rate of return on average invested capital and after tax return on sales for a medium corn wet milling plant

Financial Measure	Value
Pre-tax net income ($000)	3,615
Pre-tax ROI[*] (%)	9.8
After-tax ROI[*] (%)	5.1
After-tax return on sales (%)	3.7

[*] Average return on fixed investment calculated by financial statement method.

Table IV-4. Estimated cash flow for a medium corn wet milling plant

Financial Measure	Value
Annual cash flow ($000)	4,742
Cash flow on average fixed investment (%)	12.9

The annual cashflow of $4.742 million is also 9.3 percent of sales. Unlike most other agricultural processing industries, the cashflow percentage to sales is relatively high for the corn wet milling industry.

Market (Salvage) Value of Assets

Fixed assets of a corn wet mill would have little value to any producer other than another corn wet miller. However, due to general growth in demand for corn refining products, one would expect that a well located plant in generally good condition would have a significant salvage value.

There is a recent known case where a corn wet mill was closed and subsequently sold to another corn refining company (i.e., Corn Sweetners, Inc. bought the Union Starch Refining Company plant at Granite City, Illinois after it was closed. Union Starch was a subsidiary of Miles Laboratories, Inc.). This plant was reported to have been operated for about six months but then reclosed. Apparently old and worn equipment resulted in inefficient operation of the plant.

Capital Structure - The average fixed investment in a corn refinery was estimated as $36.735 million for the medium sized model plant as described, and sales were estimated as $50.949 million per year. This yields an average sales of $1.39 for each dollar of investment. Compared with other agricultural processing industries, this level of sales to investment is low. A major difference in corn refining is its high capitalization requirements. Also, corn refining is a high value added processing industry compared to most other agricultural processors.

The capital requirements estimated for the medium model plant are presented in Table IV-5. The replacement value of $60.25 million assumes a breakdown of 75 percent equipment and 25 percent for buildings and site. Total annual working capital is estimated as $11.016 million which is equal to 25 percent of total operating costs, including raw material (corn) costs. Corn refiners maintain inventories of both raw materials and finished goods as well as normal accounts receivables.

Cost Structure - Model plant data and budgets were prepared to estimate the cost structure of representative operations.

Fixed or plant related expenses were defined as those which do not directly vary as a function of throughput. These expenses include:

Table IV-5. Estimated replacement value and working capital requirements for a medium corn wet milling plant

Capital Component	Requirement ($000)
Replacement value of plant, equipment & site	60,250
Total working capital	11,016
Replacement value of total assets	71,266

- maintenance and supplies
- taxes and insurance
- plant and labor overhead
- sales, general and administrative

Additionally cost estimates were made for depreciation and interest costs. Variable or production related expenses were defined as those which will generally vary proportionately with throughput--in other words, a fixed amount per unit processed. They include:

- raw materials
- power
- water
- process supplies, chemicals, etc.
- operating labor
- plant supervision and fringe benefits

Fixed costs - Indirect operating costs, as shown in Table IV-6, represent 7.4 percent of sales in the budgeted plant. This is higher than the other grain milling industries and is primarily due to the typically large selling and related costs involved. Sales offices and distribution centers are common in the industry since many sales are to industrial outlets.

Depreciation, at 5.6 percent of sales is relatively high compared with other agricultural processors. The capital intensive nature of corn refining is the principal cause.

Interest costs are nominal at 0.8 percent of sales.

Variable costs - Variable costs for the corn wet milling industry are also shown in Table IV-6 for two major components: raw materials (corn), and direct operating costs. Of special note is the relatively high direct operating cost component representing 42.1 percent of sales. Also, the raw materials costs (for corn) are relatively low as compared to other agricultural processors. Both of these relative values reflect that corn refining is indeed a high value added industry.

Table IV-6. Estimated costs for a medium corn wet milling plant

Item	$000	Percent
Sales	50,949	100.0
Raw materials	18,819	36.9
Direct operating costs	21,458	42.1
Indirect operating costs	3,787	7.4
Depreciation	2,862	5.6
Interest	408	0.8
Total before-tax cost	47,334	92.9

Distribution of Model Plant Financial Data

The financial data base on which the model plant characteristics were based were extremely limited for the corn wet milling industry. A variety of engineering and financial guidelines were used to construct the financial characteristics of the model plant. A summary of the financial characteristics, plus various additional values and assumptions are presented in Table IV-7. The model reflects the basic conditions and characteristics of this industry.

Considerable reliance was placed on common financial data sources as stated previously for bulgur and rice. Also, particular use was made of the 1967 Census of Manufactures volume and value of shipment data to estimate an average mix of end products (and by-products) produced by corn refiners.

Finally, a concern exists over the choice of appropriate commodity prices and product values. Current commodity prices are at all time highs. Corn refiners will be dramatically affected and problems will be faced in markets where substitutes for corn products exist, e.g., cane and beet sugar vs. corn sweeteners.

Table IV-7. Summary of financial data pertaining to the corn wet milling model plants

Item	Units	Values 30,000 bu./day	 60,000 bu./day	 90,000 bu./day	Remarks
Utilization	%				
Annual throughput	1,000 bu.	7,650	15,300	22,950	300 days x 60,000 bu x 85
Sales	$1,000	25,475	50,949	76,424	Bu. processed basis. Man products. $3.33/bu. value, f.o.b. mi
Raw product costs	"	9,410	18,819	28,229	$1.23/bu., f.o.b. mill (1968-71)
Variable costs	"	11,054	21,458	31,602	85% of operating costs, excluding corn
Fixed costs	"	1,951	3,787	5,577	15% of operating costs, excluding corn
Cash earnings	"	3,060	6,885	11,016	
Depreciation	"	1,722	2,862	3,860	5% equipment; 4% bldg.
Interest	"	204	408	611	
Pre-tax income	"	1,134	3,615	6,545	
Net income	"	590	1,880	3,403	
After-tax cash flow	"	2,312	4,742	7,263	
Replacement costs	"	36,250	60,250	81,250	75% equipment: 25% bldg.
Working capital	"	5,604	11,016	16,352	25% operating cost
Current liabilities	"	2,242	4,406	6,541	40% total working capital
Average fixed investment (AFI)	"	21,487	36,735	50,436	
Pre-tax income/AFI	Ratio	.053	.098	.130	
Net income/AFI	"	.027	.051	.067	
Cash flow/AFI	"	.108	.129	.144	
Net income/sales	"	.025	.037	.045	

Financial data for the 60,000 bu/day plant (medium) are presented in the text. Data for the 30,000 and 90,000 bu/day plants are subsequently used in the Impact Analysis section below.

Ability to Finance New Investment

In the earlier section on bulgur, general requirements for financing new investment were set forth, along with the general conditions in the milling industry. Table II-8 presented selected financial data for all grain milling firms.

It is extremely difficult to segregate financial data for wet corn milling operations. Standard and Poor's Industry Survey has a ten-year (1967-71) series for a group of corn refiners, including three companies which operate a total of seven wet corn mills (of a total of 17). Although wet corn milling does not constitute the entire operations of these three companies, their financial data provide useful insights into the industry. A fourth company, Hubinger, which operates one plant has financial data available for 1970 and 1971.

The three companies from Standard and Poor's Industry Survey are summarized in Table IV-8 from 1962 through 1971; Hubinger Co. is included as data are available. CPC International experienced a steady decline in net profit on sales from 5.9 percent in 1963 to 3.6 percent in 1971; Staley had an irregular pattern of profits on sales which peaked at 4.3 percent in 1966, fell to 2.3 percent in 1968, rose to 2.8 percent in 1969 and fell to 1.6 percent in 1971; American Maize peaked in 1965 at 6.7 percent and declined irregularly to 3.3 percent in 1969 and to 3.8 percent in 1971. Hubinger experienced a general decline from 6.3 percent in 1964 to 2.2 percent in 1971. Corn refiners as a group experienced a general decline from 5.9 percent in 1962 to 3.3 percent in 1971.

These same companies have demonstrated quite different performances in profit as a percent of net worth. CPC has had a remarkably steady return ranging from 16.4 percent in 1963 to 13.3 percent in 1971; Staley has fluctuated from 12.1 percent in 1966 to 5.2 percent in 1971; American Maize has bounced from 5.2 percent in 1967 to 12.5 percent in 1968, with a 1971 return of 11.5 percent. Hubinger earned 13.0 percent on net worth in 1970 but dropped to 5.5 percent in 1971.

At the same time, except for Hubinger, the companies had a fairly high debt-equity ratio in 1971 -- CPC at 50 percent, Staley at 44 percent and American Maize at 44 percent. Hubinger had only 10.6 percent. This places the three at the upper part of the range for manufacturing companies and considerably higher than the 36 percent average of all firms in 1970. When combined with the earnings picture, the debt ratio indicates that there may be some serious limitations on the ability of firms with low earnings to finance pollution abatement installations with borrowed funds.

Table IV-8. Selected financial data for four wet corn milling firms, 1962-1971 [1]

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Net Profit as a Percent of Sales										
CPC International	5.8	5.9	5.5	5.6	5.6	4.7	4.7	4.5	4.4	3.6
A. E. Staley	2.7	3.0	2.4	3.8	4.3	2.5	2.3	2.8	2.7	1.6
American Maize-Prod.	4.4	4.1	5.4	6.7	5.6	2.8	4.6	3.3	3.8	3.8
Hubinger	--	--	6.3	5.8	5.2	3.4	4.7	4.0	4.9	2.2
Net Profit as a Percent of Net Worth (Estimated)										
CPC International	15.6	16.4	15.4	16.2	16.3	13.8	14.3	15.0	15.1	13.3
A. E. Staley	6.4	7.0	6.9	10.2	12.1	7.3	7.0	8.5	8.3	5.2
Am. Maize-Prod.	7.0	6.7	9.1	7.5	7.3	5.2	12.5	9.1	10.6	11.5
Hubinger	--	--	--	--	--	--	--	--	13.0	5.5
Current Ratio (Current Assets to Current Liabilities)										
CPC International	--	--	--	--	--	--	--	--	1.8	1.7
A. E. Staley	--	--	--	--	--	--	--	--	1.9	1.9
Am. Maize-Prod.	--	--	--	--	--	--	--	--	4.1	4.2
Hubinger	--	--	--	--	--	--	--	--	2.5	2.8

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[1] Source: Standard and Poor's Industry Survey, Nov. 23, 1972 and Moody's Industrial Manual, 1972.

The short-term debt situation appears marginal. Only brief data are available, but it indicates that the ratio of current assets to current liabilities for grain milling in general was 1.9 to 2.2 in 1971. CPC had a current ratio 1.7, Staley of 1.9, American Maize of 4.2 and Hubinger of 2.8.

The corn refiners have traditionally been subject to widely varying earnings. Profits are affected by corn production, corn costs and the production and prices of related products. Margins may vary from product to product and from year to year since the refiner has little control over the factors affecting his profit margins. This makes equity offerings less attractive than for industry in general.

As evidence of this, corn refiners stock prices declined by about 45 percent from 1964 to 1972 while Standard and Poor's 425 industrial stock index rose approximately 60 percent. The price earnings ratio for corn refiner stocks also declined from a high-low range of 28-20 in 1962 to 17-12 in 1971. These facts indicate that equity financing has become less attractive for corn refiners.

On balance, however, the foregoing data indicate that the wet corn milling group has adequate financial strength to finance pollution abatement from both internal and external sources. At the same time, any further deterioration in earnings will diminish the industry's ability to meet future obligations. A fall in corn prices would help restore profit margins and strengthen the financial position of the group.

Pricing

Prices in the corn wet milling industry involve a multitude of end products and byproducts from corn refining. The "basic" products of the industry are: (1) corn starch, (2) dextrin (a "cooked" or "roasted" starch for industrial uses, especially in adhesives), (3) corn syrup, and (4) corn sugar (dextrose). However, many other products may be produced by further processing. Also, byproducts such as corn oil, corn gluten feeds and meal, steepwater concentrate and others serve additional markets.

Because so many products are produced and different markets are involved, pricing is a complex question. In this brief description only some of the major factors involved are described.

Price Determination

Demand

Products of the corn refining industry are utilized in the home, by industry for food and industrial purposes, and in feeding livestock. Uses in the home include corn syrup for table use, corn starch for home cooking and laundering, and corn oil for cooking. Much greater volumes, however, are utilized by manufacturing plants of all kinds: textile mills, paper mills, commercial laundries, foundries, tobacco and cigarette plants, rubber factories, chemical and drug manufacturers, feed mixers, soap makers and many food processors -- such as bakers, confectioners, brewers, soft-drink bottlers, canners and frozen food packers. These industries use the refined corn products as raw material input for further processing.

Products for the home are packed in consumer-sized containers and shipped to wholesale or retail outlets for distribution. Industrial markets and users generally require deliveries in commercial containers or in bulk lots. For example, corn syrups are usually shipped in steel cans, drums, tank trucks of various sizes, and in 8,000 gallon or more railroad tank cars. The dry sweetners (dextrose and corn syrup solids) are shipped mostly in 100-pound multiwall paper bags. Closed hopper cars are sometimes used for bulk shipments of dextrose.

Corn starch is either packaged or shipped in bulk to major users, such as the paper and textile industries. Corn oil for home consumers and small industrial users is packed in bottles, cans, and drums of various sizes. Shipments to large users are usually made in tank trucks and railroad tank cars.

Each of the end-products or byproducts of the corn refining industry effectively enters different markets with varied demand conditions. Many sales are made via individual customer negotiation and often in advance of production. Refining operations are then scheduled and the product mix modified to meet sales demands. However, certain end products such as corn oil, corn syrup and dextrose have established wholesale markets (New York and Chicago) where bulk rate competitive prices are determined. Wholesale prices for corn gluten feed (Chicago and Tri-cities) and corn gluten meal (Tri-cities) are also regularly reported for the industry--although value of shipment data by product class are included in periodic Census of Manufactures reports.

Despite the lack of formal markets for many corn refining products, the industry is considered to be very competitively structured. Firms compete with each other for industrial and consumer sales. Also, some of the main products (corn syrup, dextrose and oil) compete with other commodity sources of sweetners and food oils. For example, corn sweetners compete with cane and beet sugar sources which are dominant in the sweetner market. Corn oil competes with various other grain and vegetable oil sources such as cottonseed, palm, peanut, soybean and safflower oils.

An overall summary of the level of demand for wet corn milling products (primary only) is indicated in quantity and value of shipment data reported by the Census of Manufactures. The most recent data available are for 1967 as shown in Table IV-9 . The value of total shipments for 1967 was $646.6 million when 207 million bushels of corn were milled by the wet process. For comparison, about 250 million bushels of corn were processed in 1972 which is a 21 percent increase. Value of shipments have increased proportionately more which is indicative of a growing demand for corn refining products.

As indicated above, refined corn products have a wide variety of both food and non-food (industrial) uses. About 60 percent of the primary products are said to go into food products, but the proportions of each into food/nonfood uses differ approximately as follows:

Table IV-9. Quantity and Value of Shipments by All Producers in SIC 2046: Wet Corn Milling, 1963 and 1967

Product	Total shipments including interplant transfers			
	Quantity		Value	
	1963	1967	1963	1967
	--(million pounds)--		--(million dollars)--	
Wet corn milling products, total	--	--	547.2	646.6
Corn syrup, unmixed				
Low (28 to 37 D.E.)[1]	89.4	210.5	4.5	10.5
Regular (38-47 D.E.)	1,200.5	1,423.0	60.1	66.6
Intermediate (48-57 D.E.)	128.4	175.0	6.4	8.3
High (58-67 D.E.)	843.0	871.4	42.5	43.2
Extra High (68 and over D.E.)		60.6		2.8
Corn sugar	1,093.6	1,227.9	71.5	81.6
Corn syrup solids	110.4	127.1	8.8	10.4
Cornstarch, including milo	2,565.1	3,119.0	177.3	199.5
Dextrin	118.9	168.7	9.9	16.0
Corn Oil (crude and refined)	--	--	60.9	76.4
Wet Process corn byproducts				
Steepwater concentrates (50%)	42.7	78.0	1.0	1.5
Corn gluten feed	1,316.8	2,365.9	27.4	55.1
Corn gluten meal	1,078.2	875.2	33.3	36.6
Other byproducts	N.A.	341.4	25.8	27.1

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[1] D. E. = dextrose equivqlent

Source: Bureau of the Census, Census of Manufacturers, U. S. Department of Commerce, 1967.

Product	Percent into Food	Percent into non-food uses
Corn starch	12%	88%
Corn syrup	94%	6%
Corn sugar (Dextrose)	85%	15%

Corn oil, a byproduct of the refining process, is also primarily used in food products.

An effective measure of the relative demand for corn products used in foods is per capita consumption over time as shown in Table IV-10. Corn sweetners (corn syrup and dextrose) have grown in importance in the caloric sweetner market which is suggested by the increased per capita data shown. Corn starch for food purposes has remained relatively constant on a per capita basis for the past twenty years although total demand has increased with the growth in population. Again, corn starch in food uses is a relatively minor portion of the total demand for starch, however. Corn oil consumption has also remained relatively constant on a per capita basis for many years.

Non-food uses account for an increasing percentage of the steadily growing total demand for corn starch. Most of the starch used industrially goes into the paper and textile industries. Estimated average annual use of corn starch by these industries and in total for all industries is shown in Figure IV-1 . Of the total 2,470 million lb. estimated for 1969, 1,600 million lbs. (65%) was used for paper and paper products, 350 million lb. (14%) was used in the textile industry, and 520 million lb. (21%) was used for a wide variety of other industrial purposes. Other industrial uses include applications in adhesives, building materials, foundry binders, laundry starches, explosives, oil-well muds and other mining applications. (Dextrin, a roasted starch, is included with the above. It is used almost enitrely for industrial purposes, primarily in the manufacture of adhesives. Dextrin is considered a basic product of the industry along with regular starch, syrup and sugar.)

Non-food uses of corn syrup and corn sugar also include a wide range of industrial applications. Examples of applications of each are as follows:

Table IV-10. Per capita consumption of selected corn milling products, 1960-1971

Year	Corn Sugar	Corn Syrup	Corn Starch [1]	Corn Oil
1960	3.7	10.1	1.8	1.9
1961	3.7	10.6	1.8	2.0
1962	3.9	11.5	1.8	2.0
1963	4.5	12.3	1.8	2.0
1964	4.4	13.6	1.8	2.3
1965	4.5	13.7	1.8	2.4
1966	4.6	14.0	1.8	2.2
1967	4.6	14.1	1.8	2.2
1968	4.7	14.8	1.9	2.2
1969	4.9	15.4	1.9	2.1
1970	4.9	16.0	1.9	2.2
1971	5.2	16.2	1.9	2.1

[1] Food use only.

Sources: National Food Situation, ERS, USDA, Feb., 1973.

U. S. Fats and Oils Statistics 1950-71, ERS, USDA, Statistical Bulletin No. 489.

Senti, F. R. and W. C. Schaefer, "Corn--Its Importance in Food, Feed, and Industrial Uses," Cereal Science Today, 17:352-356, November, 1972.

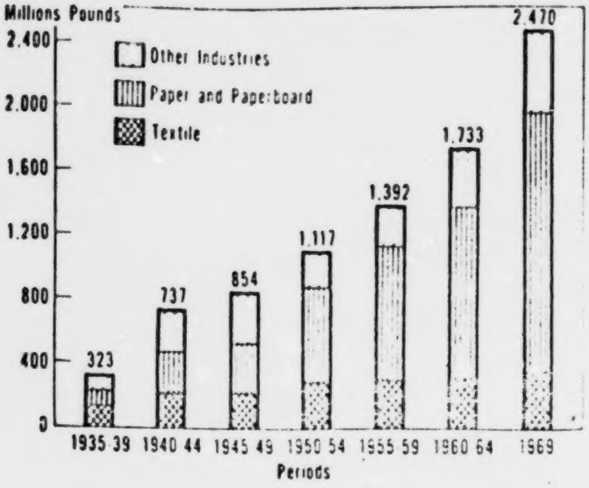

Figure IV- 1 . Estimated industrial use of corn starch in the U.S., expressed as annual averages for the periods shown. (From Moore and Dwoskin)

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Corn Syrup Applications

Adhesives
Chemicals
Dyes and inks
Explosives
Leather tanning
Metal plating
Glassive and parchment paper
Shoe polish
Textile finishing
Tobacco products

Corn Sugar Applications

Acid production
Adhesives
Organic chemicals
Dyes
Enzymes
Explosives
Fermentation products
Leather tanning
Textile dying and finishing

Corn oil also has some non-food uses such as in pharmaceuticals, in leather dressings and as a carrier for insecticides. Also, and most importantly, crude corn oil (and its derivative, soap stock) is used in soap making.

Other corn wet milling products and byproducts are produced and marketed. Corn gluten feed and meal, and corn oil meal are important byproducts which are sold as livestock feeds primarily to the dairy, poultry and hog industries. Steepwater concentrate is also utilized either in corn gluten feed or for use in the pharmaceutical industry to produce antibiotics, such as penicillin, and certain vitamins. Other products such as lactic acids, enzymes, alcohol and distilled grains are produced and marketed by some firms in the industry.

Supply

Supply of corn wet milling and refining products for the past twenty years has steadily increased with high correlations to growth in population, GNP, and total food production. Corn refining products have either maintained or increased their relative importance in food and industrial uses and the industry has grown in volume of products supplied as a consequence.

The supply of corn wet milling products is indirectly reflected given the amount of grain corn milled by the wet milling industry. The annual volumes milled for 1968 to 1972 are shown in Table IV-11 . In 1972 an estimated 250 million bushels was processed and this represented about 4.3 percent of the total corn utilized.

Table IV- 11. U.S. Corn Utilization, 1968-1972

Use	1968		1969		1970		1971		1972	
	Mill. Bu.	Percent	Mill. Bu.	Percent	Mill. Bu.	Percent	Mill. Bu.	Percent	Mill. Bu.	Percent
Feed	3,580	79.5	3,795	79.0	3,581	79.7	3,978	76.8	4,365	75.5
Export	520	11.6	598	12.5	502	11.2	786	15.1	984	17.1
Wet Milling	221	4.9	226	4.7	229	5.1	242	4.7	250	4.3
Dry Milling	114	2.5	116	2.4	119	2.6	115	2.2	116	2.0
Alcohol	33	.7	31	.6	24	.5	25	.5	26	.4
Breakfast Foods	22	.5	22	.5	22	.5	22	.4	23	.4
Seed	12	.3	13	.3	17	.4	15	.3	16	.3
Total Utilization	4,502	100.0	4,801	100.0	4,494	100.0	5,183	100.0	5,780	100.0

Source: Feed Situation, ERS, USDA, 1968-1972.

Since the corn wet milling industry utilizes only a relatively small part of the total corn supply, the availability of grain corn is not regarded as a physically limiting factor of production. Corn wet millers do, however, purchase shelled corn competitively in a market dominated by livestock feed manufacturers; and, corn prices are effectively exogenously determined as viewed by the corn wet millers. It is also noted that corn wet millers typically do not maintain large storage reserves of grain. They tend to buy currently, although the commodity futures market is often used to hedge corn purchases, especially during periods of uncertainty about the size of the upcoming corn crop.

Prices

Prices for each of the numerous end products of the corn refining industry are effectively determined in separate and often unrelated markets. Prices are not reported for all products, so tracing market trends is difficult without first-hand knowledge of industry sales and pricing procedures.

As a brief overview of prices and price trends in the corn wet milling industry, selected data from Wholesale Prices and Price Indexes (published monthly by Bureau of Labor Statistics, U.S. Department of Labor) are presented in Table IV-12. First, it is noted that all but corn syrup and corn gluten feed were priced considerably higher in 1972 than in 1967 based on the index values. However, the gluten feed prices almost doubled between July, 1972 and February, 1973. Corn syrup also began to recover, and other items, except crude corn oil were generally stable.

Several factors are pertinent to the specific changes involved, e.g., an unprecedented "price war" for corn syrup began in December, 1971 but prices were beginning to return to normal by February 1973; and livestock feed demand increases plus unusual export demands for U.S. grain commodities seriously disrupted livestock feed markets. However, more generally, the price indexes shown illustrate the independence of various markets for different end products of the corn wet milling industry.

Corn wet millers often have little control over product prices in markets where there are close substitutes. As was mentioned previously, corn sweetners compete with sugar (cane and beet) and thus changes in production costs cannot necessarily be passed through to consumers. This will be true regarding the effects of pollution control costs (just as current increased corn costs will likely severely effect industry relative to current market prices).

Table IV-12. Selected prices and price indexes for corn wet milling industry end products.

Product		Unit	July, 1972		February, 1973	
			Price	Index	Price	Index
			$	(1967=100)	$	(1967=100)
Corn syrup, confectioners		100 lb.	3.675	78.4	4.214	89.9
Crude corn oil		lb.	.150	120.8	.173	138.7
Refined corn oil		lb.	.203	127.9	.198	125.3
Corn gluten feed		Ton	44.00	91.0	80.000	165.5
Dextrin	Canary Dark	100 lb.	11.080	127.5	11.080	127.5
	White		10.820	126.8	10.820	126.8

Source: Wholesale Prices and Price Indexes, Bur. Labor Statistics, USDL, for Feb. 1973, (April 1973), and for July, 1972, (November 1972).

Corn oil, gluten feed and meal, and steepwater concentrates also are sold in markets with relatively close substitutes even though the markets are different.

Of the basic products, starch and dextrin are the least affected by substitute products. Corn starch comprises about 93% of the starch market and most price increases could likely be passed through to consumers (mostly industrial). Dextrin is even more unique and free from major competition.

Despite the complexity in arriving at "representative" prices for this industry, price data was needed to assess the financial impacts of anticipated water pollution control costs. Because of peculiarities which may exist from year-to-year, estimated average 1967-1971 prices (and imputed values) were developed for the model plant analysis.

For reference, and as a guide to the product mix assumed, the estimated values used in this study are as shown in Table IV-13. It is believed that representative gross margin data is best reflected in the manner shown.

Table IV-13. Corn wet milling, gross margin per bushel of corn processed

Final Products	Estimated Pounds [1] per Bu. Processed	1967-71 Ave. [2] Price Per Pound	Value Per Bu. Ground
Starch			
Cornstarch	15.1	.072	1.09
Dextrin	.8	.107	.09
Sweeteners			
Corn Syrup	13.2	.067	.88
Corn Syrup Solids	.6	.081	.05
Corn Sugar	5.9	.090	.53
Oil	1.9	.169	.32
Byproducts			
Corn Gluten Feed	11.4	.024	.27
Corn Gluten Meal	4.2	.043	.18
Steepwater	.4	.020	.01
Other byproducts	1.6	.082	.13
	55.1		
		Total	3.55
		Transportation Differential [3]	-.22
Total Sales (estimated value per bushel processed f.o.b. mill)			3.33
Cost of Raw materials [4]			1.23
Gross Margin			2.10

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[1] Estimates based on actual quantity of each end product produced in 1967 compared to total bushels of corn ground by the wet milling industry in 1967.

[2] Average prices are determined by multiplying the 1967 Census of Manufactures price by the 1967-71 average wholesale price index for each product or group of products.

[3] Prices on corn sweeteners are quoted on New York basis. Prices on corn gluten feed and meal are quoted on Chicago bases. Transportation allowance reflects shipment from plant to market of these products to give FOB mill values.

[4] 1967-71 average price of corn per bushel, No. 3 yellow, Chicago. Source: Statistical Bulletin No. 410, ERS, USDA, July 1972.

V. ECONOMIC IMPACT METHODOLOGY

The remaining portion of this grain milling industry study is devoted to analyzing the economic impact of pollution abatement requirements under the Federal Water Pollution Control Amendments of 1972. The preceding findings, plus the addition of estimated pollution control requirements and costs, will serve as the basis for the impact analysis.

Proposed Standards

For the purposes of the impact analysis, three levels of wastewater treatment were considered for each applicable segment of the grain milling industry:

Level I: (BPT)	Best practicable control technology currently available - to be met by 1977.
Level II: (BAT)	Best available technology economically achievable - to be met by 1983.
Level III: (NSPS)	New source performance standards - to be applied to all new facilities that discharge directly to navigable waters - to be met by approximately January 1, 1974.

A fourth level--new source pretreatment standards--which would be applied to all facilities that use municipal systems constructed after promulgation of the proposed guidelines was not considered. No cost data were provided for these standards. It is noted, however, that grain milling wastewaters are generally considered compatible for treatment in normal municipal treatment systems.

It is further noted that the new source performance standards (NSPS) above were considered equal to the best available technology (BAT) standards. The treatment requirements and costs were also assumed to be equal.

Specifications and costs of each treatment level as described below were supplied by EPA. These data are comparable with limited alternative sources of cost data, and thus no additional cases were examined. However, to assess the sensitivity of impacts to the estimated pollution control costs, a range of estimated costs of plus or minus thirty percent (± 30%) were also analyzed.

The specific impacts examined included:

1. Price effects
2. Financial effects
3. Production effects
4. Employment effects
5. Community effects
6. Other effects

The types of analysis planned for each of these effects is outlined following a brief summary of the general methodology used.

General Methodology

The basic approach taken in the impact analysis is similar to the normally done for any feasibility capital budgeting study of new investments. The problem is essentially one of deciding whether a commitment of time and money to a project (in this case, adding pollution control facilities) is worthwhile in terms of net benefits derived. The problem is complicated in that benefits accrue over time and generally simplifying assumptions are required to project into the future. Also, many unique factors of individual operations within an industry cannot be explored.

The core analysis for this study was based upon synthesizing physical and financial characteristics of the various industry segments through model or representative plants. Incremental impacts of pollution control requirements were then assessed in terms of the same model plants. The estimated cash flows for selected model plants were summarized in Chapters II-IV.

The primary factors involved in assessing the financial and production impacts of pollution control are profitability changes, which are a function of the cost of pollution control and the ability of firms to pass along these costs in higher prices. Other factors, of course, influence production and closure decisions -- such as personal values, ability to finance new investments, relationship of the plant in the total corporate structure, and many others.

While these and other factors are relevant in business decisions, emphasis is given herein to economic analysis to provide insight into potential business responses to new investment decisions as represented by required investment in pollution control facilities. Given expected pricing conditions, the impact on profitability (and possible plant closure) can be determined by simply computing the ROI (or other profitability measures) under conditions of the new price (if changed) and the incremental investment in pollution control. The main consequence of profit changes is the probable impact on the plant in terms of plant shutdown or making the required investment to meet pollution control requirements.

In the most fundamental case, a plant will be closed when variable expenses (Vc) are greater than revenues (R) since by closing the plant, losses can be avoided. However, in practice plants continue to operate where apparently $Vc > R$. Reasons for this include:

- lack of cost accounting detail to determine when $Vc > R$.
- opportunity cost of labor or some other resource is less than market values. This would be particularly prevalent in proprietorships where the owner considers his labor as fixed.
- other personal and external financial factors.
- expectations that revenues will shortly increase to cover variable expenses.

A more probable situation is the case where $Vc < R$ but revenues are less than variable costs plus cash overhead expenses (TCc) which are fixed in the short run. In this situation, a plant would likely continue to operate as contributions are being made toward covering a portion of these fixed cash overhead expenses. The firm cannot operate indefinitely under this condition, but the length of this period is uncertain. Basic to this strategy of continuing operations is the firm's expectation that revenues will increase to cover cash outlay. Factors involved in closure decisions include:

- extent of capital resources. If the owner has other business interests or debt sources that will supply capital input, the plant will continue.
- lack of cost accounting detail or procedures to know that $TCc > R$, particularly in multiplant or business situation.
- labor or other resources may be considered fixed and the opportunity cost for these items is less than market value.

Identification of plants where $TCc > R$, but $Vc < R$ leads to an estimate of plants that should be closed over some period of time if revenues do not increase. However, the timing of such closures is difficult to predict.

The next level of analysis, where $TCc < R$, involves estimating the earnings before and after investment in pollution abatement. So long as $TCc < R$ it seems likely that investment in pollution control will be made and plant operations continued so long as the capitalized value of earnings (CV), at the firms (industry) cost of capital, is greater than the scrap or salvage value (S) of the sunk plant investment. If $S > CV$, the firm could realize S in cash and reinvest and be financially better off. This presumes reinvesting at least at the firm's (industry's) cost of capital.

Computation of CV involves discounting the future earnings flow to present worth through the general discounting function:

$$V = \sum_{n=1}^{t} A_n (1+i)^{-n}$$

where

V = present value
A_n = a future value in n^{th} year
i = discount rate as target ROI rate
n = number of conversion products, i.e., 1 year, 2 years, etc.

It should be noted that a more common measure of rate of return is the book rate, which measures the after-tax profits as a ratio of invested capital, net worth or sales. These ratios should not be viewed as a different estimate of profitability as opposed to DCF measures (discounted cash flow) but rather an entirely different profitability concept. The reader is cautioned not to directly compare the DCF rates with book rates. Although both measures will be reported in the analyses, the book rate is reported for informational purposes only.

The two primary types of DCF measures of profitability are used. One is called the internal rate of return or yield and is the computed discount rate (yield) which produces a zero present value of the cash flow. The yield is the highest rate of interest the investor could pay if all funds were borrowed and the loan was returned from cash proceeds of the investment. The second DCF measure is the net present value concept. Rather than solve for the yield, a discount rate equivalent to the firms cost of capital is used. Independent investments with net present values of above zero are accepted; those below zero are rejected. The concept of comparing capitalized earnings with the sunk investment value is a variation of the net present value method.

The data input requirements for book and DCF measures are derived, to a large extent, from the same basic information although the final inputs are handled differently for each.

Benefits

For purposes of this analysis, benefits for the book analysis have been called after-tax income and for the DCF analysis after-tax cash proceeds. The computation of each is shown below:

After tax income = $(1 - T) \times (R - E - I - D)$

After tax cash proceeds = $(1 - T) \times (R - E - D) + D$

where

T = tax rate

R = revenues

E = expenses other than depreciation and interest

I = = interest expense

D = depreciation charges

Interest in the cash proceeds computation is omitted since it is reflected in the discount rate, which is the after-tax cost of capital, and will be described below. Depreciation is included in the DCF measure only in terms of its tax effect and is then added back so that a cash flow over time is obtained.

A tax rate of 48 percent was used throughout the analysis. Accelerated depreciation methods, investment credits, carry forward and carry back provisions were not used due to their complexity and special limitations. It is recognized that in some instances the effective tax rate may be lower in a single plant situation, but with the dominance of multiplant firms, the firm's tax rate will be close to the 48 percent rate.

Revenue, expenses, interest and depreciation charges used were those discussed in Chapters II-IV and Chapter VI for pollution control facilities. These items were assumed to constant over the period of analysis.

Investment

Investment is normally thought of as outlays for fixed assets and working capital. However, in evaluating closure of an on-going plant where the basic investment is sunk, the value of that investment must be made in terms of its liquidation or salvage value, that is, its opportunity cost or shadow price. [1/] For purposes of this analysis, sunk investment was taken as the sum of equipment salvage value plus land at current market value plus the value of the net working capital (current assets less current liabilities) tied up by the plant. This same amount was taken as a negative investment in the terminal year. Replacement investment for plant maintenance was taken as equal to annual depreciation, which corresponds to operating policies of some managements and serves as a good proxy for replacement in an ongoing business.

Investment in pollution control facilities was taken as the estimates provided by EPA and shown in Chapter VI. The cost data provided represent estimated total facilities and operating costs for water pollution control, although at least some plants have partially completed construction of required facilities. The average incremental costs required may therefore be less than shown; however, the model plant data assumed no pollution control. The overall affects of pollution control are projected for the model plant cases. To reflect the effect of in-place facilities, pollution control costs of -30% of the total are also shown. In this manner, the impact of lower incremental costs can be judged.

The above discussion refers primarily to the DCF analysis. Investment used in estimating book rates was taken as invested capital - book value of assets plus net working capital. In the case of new investment, its book rate was estimated as 50 percent of the original value.

[1/] This should not be confused with a simple buy sell situation which merely involves a transfer of ownership from one firm to another. In this instance, the opportunity cost (shadow price) of the investment may take on a different value.

Cost of Capital - After Tax

Return on invested capital is a fundamental notion in U.S. business. It provides both a measure of actual performance of a firm as well expected performance. In this latter case, it is also called the cost of capital. The cost of capital is defined as the weighted average of the cost of each type of capital employed by the firm, in general terms equities and interest bearing liabilities. There is nomethodology that yields the precise cost of capital, but it can be approximated within reasonable bounds.

The cost of equities was estimated by two methods -- the dividend yield method and the earnings stock price (E/P ratio) method. Both are simplifications of the more complex DCF methodology. The dividend method is:

$$k = \frac{D}{P} + g$$

where

k = cost of capital
D = dividend yield
P = stock price
g = growth

and the E/P method is simply

$$k = E/P$$

where

E = earnings
P = stock price

and is a further simplication of the first. The latter assumes future earnings as a level, perpetual stream.

The above methods for estimating the cost equity capital were explored for this industry.

The after tax cost of debt capital was estimated by using estimated 7.5 percent cost of debt and multiplying by .52 -- assuming a 48 percent tax rate. These values were weighted by the respective equity to total asset and total liabilities [1] to total asset ratios.

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[1] It is recognized that liabilities contain non interest bearing liabilities, but its weight is believed to be an adequate proxy for the weight of debt.

The average cost of capital for the grain milling industry was estimated as follows:

$$\text{Weighted Average Cost of Capital (CC)} = \frac{(1-t)(B)(A) + (1/PE)(100)}{(1 + A)}.$$

where

$$A = \frac{\text{Debt}}{\text{Equity}}$$

B = Cost of debt (before tax)

PE = Price/Earnings ratio

t = Tax rate (.48)

Based upon industry data that was available, the following ranges and averages for the above components were:

Item	Range	Average
A	.333 to 1.0	.667
B	6% to 9%	7.5%
P.E.	9.69 to 11.16	10.10

and,

CC	6.8 to 8.2	7.5%

In subsequent analyses, the 7.5% cost of capital estimate will be used to estimate various financial effects in the grain milling industry.

Construction of the Cash Flow

A twenty-two period cash flow was used in this analysis and was constructed as follows:

1. Sunk investment (salvage market value of fixed assets plus net working capital) taken in year t_o.
2. After tax cash proceeds taken for years t_1 to t_{20}.
3. Annual replacement investment, equal to annual current depreciation taken for years t_1 to t_{20}.
4. Terminal value equal to sunk investment taken in year t_{21}.
5. Incremental pollution control investment taken in year t_o for 1977 standards and year t_6 for 1983 standards.
6. Incremental pollution expenses taken for years t_1 to t_{20} for 1977 standards and years t_7 to t_{20} for 1983 standards, if additive to the 1977 standards.
7. No replacement investment taken on incremental pollution investment on assumption of a 20 year life as provided by EPA.
8. Terminal value of pollution facilities are assumed equal to zero in year t_{21}. No estimate of land values were given, but land is not believed a major factor in this industry.

Price Effects

At the outset, it must be recognized that price effects and production effects are intertwined with one effect having an impact upon the other. In fact, the very basis of price analysis is the premise that prices and supplies (production) are functionally related variables which are simultaneously resolved.

Solution of this requires knowledge of demand growth, price elasticities, supply elasticities, the degree to which regional markets exist, the degree of dominance experienced by large firms in the industry, market concentration exhibited by both the industry's suppliers of inputs and purchasers of outputs, organization and coordination within the industry, relationship of domestic output with the world market, existence and nature of complementary goods, cyclical trends in the industry, current utilization of capacity and, exogenous influences upon price determination (e.g., governmental regulation).

In view of the complexity and diversity of factors involved in determination of the market price, a purely quantitative approach to the problem of price effects was not feasible. Hence, the simultaneous considerations suggested above were made. The judgment factor was heavily employed in determining the supply response to a price change and alternative price changes to be employed.

As a guide to the analysis of price effects, the estimated price required to leave the model plant segment as well off was computed. The required price increase at the firm level was evaluated in light of the relationship of the model plant to the industry and the understanding of the competitive position of the industry. The required price increase was readily computed using the DCF analysis described above, but dealing only with the incremental pollution investment and cash proceeds.

Application of the above DCF procedure to these costs yielded the present value of pollution control costs (i.e., investment plus operating cost less tax savings). If this is known, the price increase required to pay for pollution control can readily be calculated by the formula

$$X = \frac{(PVP)\ (100)}{(1-T)\ (PVR)}$$

where:

X = required percentage increase in price

PVP = present value of pollution control costs

PVR = present value of gross revenue starting in the year pollution control is imposed

Note that this formula implies that incremental profits resulting from the price increase will be taxed at a rate of 48 percent.

Financial Effects

In Chapters II-IV, the financial characteristics of model plants were presented. These data served as the base point for the analysis of financial effects of pollution control. The primary focus of analysis was upon profitability in the industry and the ability of the firms to secure external capital. Hence, it is obvious that this portion of the analysis was not divorced from production effects since profit levels and the ability to finance pollution abatement facilities have a direct influence on supply responses--utilization of capacity and plant closures.

The measures of profitability utilized included after-tax book rate of return on invested capital and cash flow (after-tax profit plus depreciation) measurements. After-tax profit as a percent of sales was also reported to assist in comparing financial data with standard industrial measures.

In addition to these factors, two additional measures of economic profitability were also examined: (1) capitalized value of earnings, and (2) present values estimated by the procedures described. Both of these measures were calculated on pre- and post-pollution control bases.

Given these financial measurements, the ability of the industry to finance the required pollution control expenditures were re-examined in light of the financial results and the information shown in Chapters II-IV. This ability varied from one industry subsector to another due to differential financial structures, profitability and abatement requirements.

Production Effects

Potential production effects included reductions of capacity utilization rates, plant closures and stagnation of industry growth. Reductions in capacity utilization were estimated via qualitative techniques based upon the analysts' knowledge of the industry. The same was true for assessing the extent to which plant closures may be offset by increases in capacity utilization on the part of plants remaining in operation. Data limitations and time constraints required that the impact of pollution control standards upon future growth of the industry also be estimated via qualitative methods.

The remaining effect, plant closures, was difficult to measure realistically. As a starting point in the plant closure analysis, a shutdown model was employed to indicate which model plants should close--the marginal operations and the sound operations. These conclusions assumed that a plant would close when the net present value of the cash flow is less than zero.

It was recognized that the use of models to represent an industry is imperfect and that not all of the relevant values or factors could be included in the models. Other factors were considered as necessary in the subsequent analysis.

The above analysis was done under a without-pollution control condition and a with-pollution control condition. The former established a baseline against which after-pollution control impacts were assessed.

Employment Effects

Given the production effects of estimated production curtailments, plant closings and changes in industry growth, a major consideration arose in the implications of these factors upon employment in the industry. The employment effects stemming from each of these production impacts were estimated. To the extent possible, the major employee classifications involved were examined as was potential for re-employment.

Community Effects

Although direct impacts of job losses upon a community are immediately apparent, in many cases, plant closures and cutbacks have a far greater impact than just the employment loss. Multiplier effects may result in even more unemployment. Badly needed taxes for vital community services may dwindle. Community pride and spirit may be dampened. However, in some cases, the negative community aspects of production effects may be very short-term in nature with the total impact barely visible from the viewpoint of the overall community. In a few cases, the closure of a plant may actually be viewed as a positive net community effect (e.g., a small plant with a high effluent load in an area with a labor shortage).

These impact factors will be qualitatively analyzed as appropriate.

Other Effects

Other impacts such as direct balance of payments effects were also included in the analysis. This, too, involved qualitative analyses.

VI. POLLUTION CONTROL REQUIREMENTS AND COSTS

The water pollution control standards, technology and costs used in this analysis were provided by the Environmental Protection Agency. [1/] Alternative standards were set for different segments of the grain milling industry. This information is summarized briefly below for reference. Estimated pollution control costs were also summarized for selected model plants in each segment of the industry.

Although cost data were not provided for alternative plant sizes within each segment of the grain milling industry, representative plant data, as provided, are adequate to project the overall expected impacts. Most grain milling plants currently discharge into municipal systems; consequently, only limited numbers of plants will be directly affected by the proposed guidelines and those are characterized by the model plant data presented. Also, in all segments studied, that portion of the industry which discharges to municipal treatment systems will effectively determine levels of output and prices in the industry.

Pollution Control Requirements

The Best Practicable Control Technology (BPT) and the Best Available Technology (BAT) tentative guidelines proposed for the corn wet milling, corn dry milling, parboiled rice milling and bulgur processing segments of the grain milling industry are as summarized in Tables VI-1 and VI-2, respectively.

To achieve the BPT and BAT proposed guidelines, each segment of the grain milling industry would be required to apply suitable treatment practices. In the information provided by EPA, specific possible water treatment practices were identified for each segment of the grain milling industry to achieve effluent reductions corresponding to both levels. In all cases, the BAT proposed practices assumed compliance with the BPT practices followed by additional treatment to attain the higher standards.

[1/] Based upon materials prepared for EPA in "Development Document for Effluent Limitations Guidelines and Standards of Performance, Grain Milling," by Sverdrup and Parcel and Associates, Contract No. 68-01-1503, June, 1973.

Table VI-1. BPT Pollution Control: Effluent reduction attainable through the application of best practicable control technology currently available

Industry Segment	BOD	Suspended solids	pH
	(lbs/MSBu)[1]	(lbs/MSBu)	
Corn wet milling	50.0	50.0	6-9
Corn dry milling	4.0	3.5	6-9
Bulgur	0.5	0.5	6-9
	(lbs/cwt)	(lbs/cwt)	
Parboiled rice milling	0.014	0.008	6-9

BPT Proposed Standard applies to the BOD, Suspended solids and pH columns.

Source: EPA and Sverdrup & Parcel and Associates

[1] MS Bu equals thousand standard bushels.
Average daily value.

Table VI-2. BAT Pollution Control: Effluent reduction attainable through the application of best available technology economically achievable

Industry Segment	BAT Proposed Standard		
	BOD (lbs/MSBu) [1/]	Suspended solids (lbs/MSBu)	pH
Corn wet milling	20.0	10.0	6-9
Corn dry milling	2.0	1.0	6-9
Bulgur	0.3	0.2	6-9
	(lbs/cwt)	(lbs/cwt)	
Parboiled rice	0.007	0.003	6-9

Source: EPA and Sverdrup & Parcel and Associates

[1/] MS Bu equals thousand standard bushels.

For each segment of the grain milling industry, a brief summary of indicated treatment practices proposed to meet the tentative guidelines is presented below. In general terms, application of the "best practicable control technology currently available" (BPT) in the grain milling industry results in a high level of waste treatment together with, in some instances, requisite in-plant modifications. Application of the "best available technology economically achievable" (BAT) generally requires improved solids separation following activated sludge or comparable biological treatment.

The specific types of treatment and technological assumptions used to achieve the proposed guidelines are briefly as follows for each segment of the grain milling industry included in this study.

Corn Wet Milling

General Requirements

Plants in the corn wet milling industry discharging directly to surface waters must undertake major pollution abatement activities to meet effluent limitations. These activities consist of in-plant modifications and biological wastewater treatment. Plants discharging to municipalities will be under increasing pressure from the municipalities to make in-plant modifications to reduce the waste levels of their waste flows. In-plant modifications include the following:

(1) Isolate and collect polluting wasteflows.
(2) Recirculate cooling waters by using cooling tower systems or surface condensers to eliminate once-through barometric cooling waters.
(3) Isolate once-through, non-contact cooling waters for direct discharge.
(4) Dike all process areas to contain accidental spills.
(5) Install entrainment separators in steepwater and syrup evaporators.
(6) Monitor waste streams to control heavy product losses.

Corn wet mills discharging directly to surface waters must provide extensive waste treatment for process wastewaters, after careful efforts to keep wasteloads to a minimum, in order to meet effluent limitations. Treatment processes necessary to meet effluent limitation levels are as follows:

(I) BPT: Equalization and Activated Sludge - The treatment process at this level consists of grit removal, ph adjustment, nutrient addition, 12 to 18 hours of aerated equalization, complete-mix activated sludge processing, secondary sedimentation, and sludge dewatering.

(II) BAT: Equalization, Activated Sludge, and Deep Bed Filtration - Includes the Level I treatment process plus deep bed filtration.

Industry Experience

The effluent limitation levels can be met by applying current technology since each of the in-plant modifications and treatment control processes is currently being used by one or more corn wet mills. The practices have been in effect in a number of mills for several years and reduce waste loads by 25 to 50 percent in some plants. The treatment of corn wet milling wastes with activated sludge and other biological systems is practiced at seven mills. One mill presently meets effluent limitations by using an activated sludge system followed by aerated lagoons.

(I) BPT: Equalization and Activated Sludge - The treatment process at this level consists of grit removal, ph adjustment, nutrient addition, 12 to 18 hours of aerated equalization, complete-mix activated sludge processing, secondary sedimentation, and sludge dewatering.

(II) BAT: Equalization, Activated Sludge, and Deep Bed Filtration - Includes the Level I treatment process plus deep bed filtration.

Industry Experience

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Corn Dry Milling

General Requirements

The wastewaters of concern in the corn dry milling industry are generated by corn washing. Little can be done to reduce the wasteload with in-plant controls as long as corn washing is practiced. Treatment of the entire waste stream is necessary to meet the proposed effluent guidelines and consists of the following practices:

(1) Collect wastewaters including those from car washing.
(2) Primary solids separation by sedimentation.
(3) Biological treatment
(4) Final separation of solids by sedimentation.

The waste treatment practices proposed to meet the proposed guidelines are as follows:

(I) BPT: Primary Sedimentation and Activated Sludge - Treatment consists of primary sedimentation, nutrient addition, complete-mix activated sludge, secondary sedimentation, and sludge dewatering.

(II) BAT: Primary Sedimentation, Activated Sludge, and Deep Bed Filtration - Includes BPT treatment plus deep bed filtration.

Industry Experiences

Treatment of wastewater discharges is limited in the Corn Dry Milling industry. Most mills discharge to municipal systems. An unknown number discharge directly to receiving waters. The level of treatment practiced by those discharging directly to receiving waters is also unknown. One plant is known to pretreat. While the level of treatment provided is not consistent with the proposed effluent guidelines, it does show that wasteflows from corn dry mills are amenable to conventional biological treatment. The corn dry milling industry can reach the BPT and BAT guidelines by transferring proposed treatments from other food processing industries.

Bulgur Processing

General Requirements

The only wastewater of concern in the wheat flour milling industry results from bulgur processing. All of the mills producing bulgur at the present time discharge directly to municipal systems. For those plants that would be concerned with meeting new source performance standards, the treatment required includes:

(1) Primary solids separation
(2) Biological treatment
(3) Final separation of solids by sedimentation

To meet the proposed effluent guidelines, the treatment practices proposed are as follows:

> (I) BPT: Activated Sludge - This process includes an activated sludge system with nutrient addition and secondary sedimentation. Primary sedimentation is not included because of low flows.
>
> (II) BAT: Activated Sludge and Deep Bed Filtration - Deep bed filtration system is added to the BPT activated sludge system

Industry Experience

None of the bulgur mills provides wastewater treatment at the present time. The proposed treatment practices represent currently applied technology in related areas of food processing. The solids separation and biological treatment processes in use should also be applicable to the treatment of wastewater from bulgur processing.

Parboiled Rice Milling

General Requirements

The milling of rice involves no process water and no wastewater discharge. The exceptions are those mills producing parboiled rice. The wastewater from parboiling rice comes from the steeping operation. In-plant controls generally have no influence on the quantity or quality of wastewater. None of the six mills parboiling rice are known to treat their discharges which go to municipal systems. For those plants who cease to discharge to municipal systems or for new sources, the treatment required to meet effluent standards includes:

(1) Biological treatment
(2) Final separation of solids by sedimentation.

The following treatment practices are proposed to meet the effluent limitation guidelines if required:

(I) BPT: Activated Sludge - Treatment includes nutrient addition a complete-mix activated sludge process, and secondary sedimentation. The activated sludge wastes could possibly be dewatered by a centrifuge and added to the animal feed byproduct stream.

(II) BAT: Activated Sludge and Deep Bed Filtration - This treatment includes the BPT activated sludge system followed by deep bed filtration.

Industry Experience

None of the six rice parboilers in the United States is known to be treating discharges at the present time. The general nature of the wastewater indicates it can be treated by biological processes similar to those used in other food processing industries.

Pollution Control Costs

Both the BPT and BAT estimated costs for pollution control for each applicable segment of the grain milling industry are as summarized in Table VI-3. The cost data provided are for selected model plants within each segment of the industry. Cost data for alternative sized waste treatment operations were not provided; however, the model plants were selected to represent the most representative impacted size category of plants.

The plant sizes represented in Table VI-3 correspond identically or closely with the primary model plants of this study. Thus, the cost data can be used directly for comparable plants. However, in two segments, DPRA generated alternative sized plants for the impact analysis as summarized below. In the absence of scale factors for adjusting the waste treatment costs, the following relative estimates were used:

Industry	EPA (S&P) Plant Size	DPRA Plant Sizes	Cost Factor
Corn wet milling	60,000 bu/day	60,000 bu/day	1.0
		30,000 bu/day	0.75
		90,000 bu/day	1.5
Corn dry milling	30,000 bu/day	30,000 bu/day	1.0
		15,000 bu/day	0.75
Bulgur	8,000 bu/day	5,000 cwt/day (8,350 bu/day)	1.0
Parboiled rice milling	8,000 cwt/day	8,000 cwt/day thruput (500 cwt/hr max)	1.0

The scaled estimates were made to approximate costs of pollution control in alternative sized plants based on economies-of-scale relationships found in other industries. In this way, insight was gained into the relative financial effects of pollution control costs among plants within a given segment of the grain milling industry. The assumed data are subject to verification; however, it is noted that a procedure was adopted to vary the estimated pollution control costs by ± 30 percent for all cases studied. This procedure provides sensitivity information which aids in the impact assessment.

Table VI-3. Estimated "BPT" and "BAT" wastewater effluent treatment costs for selected segments of the Grain Milling Industry

Industry Segment	Type Plant	BPT Best Practicable Control Technology Currently Available		BAT Best Available Technology Economically Achievable	
		Investment	O&M [1]	Investment	O&M [1]
Wet Corn	60,000 bu/day (medium)	$2,544,000	$230,000	$2,832,000	$278,000
Dry Corn	30,000 bu/day (moderately large)	$ 291,000	$ 52,800	$ 323,000	$ 62,200
Bulgur	8,000 bu/day (medium)	$ 24,000	$ 9,200	$ 93,000	$ 15,700
Parboiled Rice	8,000 cwt/day (moderately large)	$ 313,000	$ 57,300	$ 347,000	$ 66,100

[1] Appendix A supplement to source cited. Operating and maintenance annual costs including energy and power costs.

Source: Sverdrup and Parcel and Associates, Development Document for Effluent Limitations Guidelines and Standards of Performance, Grain Milling, Draft report to EPA, June 1973.

Status of Wastewater Treatment

A major consideration in assessing the expected impacts of improved pollution controls on a given industry is the current state-of-art of pollution control and the consequent incremental requirements to achieve the proposed new abatement guidelines. In the case of grain milling, and especially for selected segments, it was found that most plants, if not all plants within a segment, are presently discharging to municipal treatment systems so that individual plant treatment facilities will not be required. Consequently, only limited numbers of plants are expected to be impacted by the proposed effluent limitation guidelines.

Four grain milling industry segments have been identified as having significant volumes of wastewater effluents irrespective of their current treatment status: Corn wet milling, corn dry milling, bulgur processing, and parboiled rice milling. Effluent limitation guidelines and proposed treatment strategies to meet the guidelines have also been established (as described above). Next, a brief summary of the state-of-art of pollution control in each of the four industry segments is presented.

Corn Wet Milling

There are currently 17 plants in this segment of the grain milling industry. Major sources of wasteflows in the corn wet milling industry are those from steepwater evaporation, modified starch production, and syrup refining. The quantity and character of the wasteflows can vary greatly, depending upon the type of cooling system and the products being manufactured. Total water use by plants in the corn wet milling industry can vary from 1 mgd to 50 mgd depending upon the types of cooling systems employed. [1/]

In general, the wastewater discharges from the corn wet milling plants can be classified as high in wasteloads. The BOD varies from 255 to 4,450 mg/l. Suspended solid levels vary from 81 to 2,458 mg/l.

Of the 17 plants in the industry, only five discharge directly into receiving waters. The other plants discharge into municipal systems. Of the five, three process wastewater in their own treatment facilities. One plant is constructing treatment facilities at the present time and the last plant plans to discharge into a municipal system now under construction.

[1/] The wide variance in water requirements is primarily due to differences in types of cooling systems employed. Those plants using a once through cooling water system will have a total water use substantially greater than plants using recirculating cooling water systems.

Corn Dry Milling

There were 124 corn dry mills in operation in 1971. Many of these mills are small and located in the Southeastern United States. The larger plants are located primarily in the Corn Belt states. The major source of wastewater from corn dry milling is from corn washing, before milling. Generally, small mills to not wash corn before milling and large mills do wash. Since approximately 90 percent of the industry production occurs in large mills, small dry corn mills can be eliminated from consideration.

Wastewater discharges from corn dry mills vary from 3.2 to 6 gal per bu of corn processed or a total wastewater flow of up to 240,000 gpd. The waste waters are characterized by high BOD and suspended solids concentrations. BOD varies from 900 to 2,700 mg/l. Suspended solids concentrations vary from 1,500 to 3,500 mg/l.

Most corn dry mills generating wasteflows discharge into municipal systems but a complete inventory of wasteflow disposal methods is not available.

Bulgur Processing

Of the normal wheat flour milling operations, only those plants engaged in bulgur production discharge significant amounts of wastewater. At the present time six plants in the United States are processing bulgur. The major source of process wastewater is from the steaming and cooking of bulgur.

The water requirements of bulgur plants are from 30,000 to 65,000 gpd depending upon the daily capacity of bulgur production. Of this total water requirement, about 10,000 to 30,000 gpd is discharged as wastewater. The wasteload of bulgur wastewater is moderately high. BOD varies from 238 to 521 mg/l. Suspended solids levels vary from 294 to 414 mg/l.

All six plants processing bulgur are reported to be discharging into municipal systems.

Parboiled Rice Milling

Rice milling ordinarily involves no process waters and no wastewaters. The exceptions are those plants producing parboiled rice. Of the 42 rice mills in the United States, only six plants produce parboiled rice.

The major source of wastewater in the parboiling plants is the steeping and cooking process. Water use varies from 17 to 25 gal/cwt of rough rice processed. Total waste water volume varies from 70,000 to 200,000 gpd.

The waste loads from the parboiling of rice can be characterized as having a high soluble BOD content and a low suspended solids level. BOD levels vary from 1,280 to 1,305 mg/l. Suspended solids vary from 33 to 77 mg/l.

All six rice mills that parboil rice are reported to discharge their waste water into municipal systems.

VII. IMPACT ANALYSIS

The impacts of direct discharge effluent guidelines on the grain milling industry as described herein will not likely be severe because most grain milling plants currently discharge into municipal treatment systems where adequate treatment can be performed. Grain milling wastewaters, which are typically high in BOD and suspended solids concentrations, are generally well suited for municipal system biological treatment.

As indicated in the preceding chapter, only limited numbers of corn wet milling and corn dry milling plants currently discharge directly into surface waters. The proposed "BPT" and "BAT" standards will therefore only apply to these subindustries of the grain milling industry. All bulgur and parboiled rice mills discharge effluents into municipal treatment systems and no BPT or BAT standards are applicable. However, consideration is given to the potential impact of new source performance standards (NSPS) which would apply to any new firms entering these industries.

The NSPS standards are assumed equal to the BAT standards provided, and the estimated costs for BAT are subsequently used for assessing the new source potential impacts. No new source pretreatment standards were provided for any subindustry and, thus, no such impact analysis is included.

The following discussion is presented on a subindustry basis: corn wet milling, corn dry milling, bulgur processing and parboiled rice milling. For each subindustry, the impacts considered in the analysis include the following:

- Price effects
- Financial effects
- Production effects
- Employment effects
- Community effects
- Other effects, e.g., balance of payments.

Because of the limited applicability of the proposed effluent limitation guidelines, many of the above effects were minimal. The greatest attention was, therefore, given to the model plant financial analyses and expected individual plant effects. In general, only individual plants rather than the industry (or subindustry) as a whole will likely be adversely impacted by the proposed standards and associated treatment requirements.

Corn Wet Milling

As an overview, the following factors regarding the corn wet milling industry were pertinent to this analysis:

- Only 5 of 17 existing plants currently discharge directly into surface waters.
- Three of the 5 plants have some biological treatment facilities in place; 1 is constructing a treatment system; and 1 will soon discharge into a municipal system under construction.
- A broad range of plant sizes, from about 24,000 to 120,000 bushels per day capacity, are involved.
- The 5 plants represent about 30 percent of the industry capacity. (The 4 plants to continue direct discharge represent about 23 percent of the total.)
- Treatment facilities for this industry are quite costly, but all plants affected have taken positive steps toward meeting prospective effluent guidelines.

The primary concern of this analysis regards the 5 (or soon only 4) plants which directly discharge to surface waters. However, as a consequence of the developments indicated, the BPT (1977) and BAT (1983) guidelines are not expected to severely alter the structure of the corn wet milling industry as a whole. Much of the expected impact will have occurred via treatment practices in place prior to the enforcement of the proposed effluent guidelines. This does not reduce, however, the treatment cost burden of the impacted plants either individually or relative to the remainder of the industry.

Price effects. Based upon individual model plant analysis, it is estimated that prices of corn wet milling products would have to increase from about 1.2 to 1.9 percent in order to cover the costs of pollution control (as provided) -- assuming no prior treatment. However, can the few firms which must treat their own wastes pass-through their higher treatment costs relative to the remainder of the industry?

Because of the competitiveness of the corn wet milling industry, it is not expected that the few impacted firms will be able to pass-through their full additional costs for pollution control. Perhaps location or product mix factors could influence some prices, but on an industry-wide basis price effects should be well below the levels indicated.

For example, even if the plants affected could pass through their costs, the industry average prices would increase only from about .3 to .5 percent. Competitive factors should result in changes of less than these levels.

A related factor is the possibility of generally higher municipal treatment charges (coupled with pretreatment practices which may be needed) that would affect the remainder of the industry. In this case industry prices would likely be affected and increased throughout the industry. However, this would not result directly from the guidelines of this study.

Financial effects. The profitability of these plants required to add pollution control facilities will be adversely affected. As an indication of the level of impact which is expected (assuming no change in prices received), net profit as a percent of sales was calculated for a series of model plant situations (Table VII-1).

Three different sizes of corn wet milling model plants, i.e., 30, 60 and 90 thousand bushels per day capacity, were examined. Both BPT and BAT pollution control costs were imposed and compared with the base case without pollution controls. Further, to assess the sensitivity of the impacts relative to the pollution control costs provided, these costs were arbitrarily varied by ± 30 percent.

As shown in Table VII-1, only the 30,000 bu/day plant is subject to a serious decline in profitability. Given the "target" pollution control costs [1/], the smallest plant showed a decline of .8% in net profit on sales (from 2.5% to 1.7%). The 60,000 and 90,000 bu/day plants showed a decline of .4%. These effects were only marginally different with the ± 30 percent in estimated pollution control costs.

[1/] Estimated pollution control costs were provided only for the 60,000 bu/day plant. This data was scaled by DPRA for the 30,000 (.75 times the 60,000 bu/day plant costs) and the 90,000 (1.5 times the costs given) bu/day model plants.

Table VII-1. Net profit as a percent of sales in the corn wet milling industry with and without pollution controls

Size and Cost [1]	Level of Pollution Control		
	None	BPT	BAT
30,000 bu/day			
Target cost plus 30%	--	1.6	1.5
Target pollution cost [2]	2.5	1.8	1.7
Target cost less 30%	--	1.9	1.9
60,000 bu/day			
Target cost plus 30%	--	3.2	3.2
Target pollution cost	3.7	3.3	3.3
Target cost less 30%	--	3.4	3.4
90,000 bu/day			
Target cost plus 30%	--	4.0	3.9
Target pollution cost	4.5	4.1	4.0
Target cost less 30%	--	4.2	4.1

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[1] No provision made for cost recovery by sale of recovered wastes.

[2] Target pollution cost estimates are those estimated by EPA for the 60,000 bu/day plant. Other data estimated by DPRA.

Also noted is that while the profitability declined in all cases, no model plant was shown to become unprofitable. Although faced with declining profitability, it does not appear that plants would close solely as a result of pollution controls.

Further measures of the financial effects of the proposed pollution controls on the corn wet milling industry are the estimated model plant financial ratios shown in Table VII-2. Both pre-tax and after-tax Return on Investment (ROI) ratios are shown for each model plant situation previously described. As explained in Chapter IV, the average invested capital is estimated as equal to one-half of the replacement cost (including pollution control costs if applicable) plus net working capital. For the Level II target pollution control cost situation the after-tax ROI drops from 2.7 to 1.9% for the small model plant, from 5.1 to 4.4% for the medium plant, and from 6.7 to 5.8% for the large plant. These data reflect the negative impact on profitability, but do not indicate that plant closures are expected.

Another measure of the financial capacity of a plant is the Net Present Value (NPV) of its future streams of costs and revenues. By discounting at the cost of capital rate, then positive NPV's would indicate the likelihood of continued plant operation versus closure. To complete this analysis, the following assumptions were made:

1. The existing plants have sunk investments but they could be disposed of today for a salvage value and reinvested elsewhere if the corn wet milling function were discontinued. However, only 10 percent of the estimated replacement cost is assumed recoverable for this industry. This relatively low value is estimated because corn wet mills are capital intensive and equipment would have little salvage value in alternative uses outside the wet milling industry.

2. Revenues and expenses are assumed to remain constant over time, i.e., 20 years of operation.

3. The estimated cost of capital for the industry is 7.5 percent.

The Net Present Values, calculated for the model plants, both with and without pollution controls -- and with a ± 30 percent change in the target pollution control costs, are as shown in Table VII-3. As indicated, all plant cases examined had positive NPV's which indicates that the plants

Table VII-2. Estimated pre-tax net income and rates of return on average invested capital in the corn wet milling industry with and without pollution controls

Size and Level of Pollution Control	Pre-tax income T+30%	Pre-tax income T [1]	Pre-tax income T-30%	Pre-tax ROI T+30%	Pre-tax ROI T	Pre-tax ROI T-30%	After-tax ROI T+30%	After-tax ROI T	After-tax ROI T-30%
		($000)			(%)			(%)	
Without Pollution Control									
30,000 bu/day		1,134			5.3			2.7	
60,000 bu/day		3,615			9.8			5.1	
90,000 bu/day		6,545			13.0			6.7	
With BPT Control									
30,000 bu/day	786	866	946	3.5	3.9	4.3	1.8	2.0	2.2
60,000 bu/day	3,151	3,258	3,365	8.2	8.6	8.9	4.3	4.5	4.7
90,000 bu/day	5,849	6,009	6,170	11.1	11.5	11.9	5.7	6.0	6.2
With BAT Control									
30,000 bu/day	738	816	911	3.3	3.6	4.1	1.7	1.9	2.1
60,000 bu/day	3,063	3,191	3,318	7.9	8.4	8.8	4.1	4.4	4.6
90,000 bu/day	5,717	5,908	6,099	10.7	11.2	11.7	5.6	5.8	6.1

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[1] T = Target pollution cost as estimated by EPA for the 60,000 bu/day plant.
Other data estimated by DPRA.

Table VII-3. Net present values of corn wet milling model plant cash flows with and without pollution controls [1/]
($000)

Level of Pollution Control and Cost	Net Present Values of Cash Flows by Plant Size		
	30,000 bu/day	60,000 bu/day	90,000 bu/day
	($000)	($000)	($000)
Without Pollution Control	6,334	19,604	35,202
With BPT Control			
Target cost + 30%	3,277	15,528	29,088
Target pollution cost [2/]	3,983	16,469	30,499
Target cost - 30%	4,688	17,409	31,910
With BAT Control			
Target cost + 30%	2,978	15,317	28,490
Target pollution cost	3,753	16,307	30,039
Target cost - 30%	4,527	17,296	31,588

[1/] Assuming 20 year operating cash flow at 7.5% cost of capital and a salvage value of 10% of original value of investment.

[2/] Target pollution cost as estimated by EPA for the 60,000 bu/day plant.
Other data estimated by DPRA.

are not likely to shutdown. The low salvage values utilized contributes to the positive NPV's and contributes toward existing plants being locked-in the wet milling industry.

The fact that all existing mills which discharge into streams are already taking positive steps to establish water treatment systems is a direct indication that no plants are likely to shutdown due to pollution control requirements *per se*. The financial characteristics displayed provide a basic rationale for the behavior being observed in this industry.

Capital availability in the corn wet milling industry for pollution control is not regarded as a major limiting factor even though capital requirements will be extensive. Both internal and external sources of capital are believed available. The conglomerate type structure of many firms in the industry broadens the base on which to generate internal capital. Also, the plants themselves generate sizeable after-tax cash flows which might be retained. Further, the industry as a whole has developed a generally stable growth pattern with favorable prospects for continued growth in demand. These latter factors strengthen the ability of firms in the industry to acquire funds from external sources.

Production effects. No curtailment in production is projected for corn wet milling industry as a whole, nor are any plant closings expected. As indicated above, all plants involved in direct discharges of wastewaters have already taken positive steps to treat their own wastes or have them treated. Current production levels are expected to be maintained.

The most serious concern regarding production involves the industry capacity for growth. Wastewater flows are substantial per 1000 bushels processed, and the capacity for waste treatment (including wasteflows into municipal systems) may be limiting in the future. Effluent overloads and periodic spills have been a reoccurring problem in the corn wet milling industry based on experience to date. Before the industry can expand output significantly, improvements will need to be made in controlling overloads and spills.

Another related concern in the corn wet milling industry is the potential for new plants in the industry and growth through time. NSPS, new source treatment standards, if applicable, would be a partial deterrent to entry. However, the *relative* effect of these standards and associated costs should be comparable to those shown above for the BAT cases. In essence, if a new plant is sufficiently viable without pollution controls, then the imposition of the estimated pollution control costs is not likely to prohibit entry. The incremental costs of pollution control represent less than 5 percent of the remainder of the capital investment required in corn wet milling.

Employment effects. Because neither production curtailments nor plant closings are projected, then no associated employment losses are expected. In the recent past, total employment in the industry has trended downward, e.g., 14,100 in 1967 and 13,500 in 1970. This has occurred even though industry output has increased. Newer plants and modernized plants tend to be less labor and more capital intensive. These trends may continue, but such changes would not necessarily be linked to pollution control changes.

Those plants which install treatment systems would require some additional labor for waste treatment control. Hence, the general effect would be to increase employment somewhat in the industry.

In contrast, the plants which must install treatment systems, without apparent increases in prices to cover pollution control costs, will be under greater pressure to improve in-plant efficiency. The employment consequences of such actions, which would be induced by the pollution control may be a factor.

Community effects. No significant community effects are projected as a result of the proposed pollution controls on the corn wet milling industry. This follows in that no plant closures nor production curtailments are expected in the industry.

Other effects. Corn wet milling products are numerous and many different markets are involved. Competitive relationships could change in some of these markets due to pollution controls in general, e.g., pollution control impacts on the beet and cane sugar industries, with relative advantages or disadvantages occurring to the corn wet milling industry. However, major disruptions originating from the corn wet milling industry are not expected.

Some products are exported, but little change is expected in general. Consequently, no major changes in balance of trade relationships are indicated.

Power and energy needs for pollution control are not estimated to be excessive; thus, this requirement is not expected to be a major problem area for the industry.

Corn Dry Milling

The corn dry milling industry is distinctly different from the corn wet milling industry in that milled products (corn grits, meal and flour) rather than "refined" products are the primary end-use products. Process wastewaters primarily involve water used for washing corn prior to milling (plus limited rail car washing water which can be eliminated using dry vacuum cleaning techniques). The effluents of this industry are quite amenable to biological waste treatment.

As background for assessing the expected economic impacts of water pollution controls on this industry, the following items are highlighted:

- Approximately 124 corn dry mills were recently in operation.
- The larger mills, primarily located in the Corn Belt States generally wash their corn prior to milling.
- The smaller mills, which grind whole corn and are concentrated in the Southeastern United States, typically do not wash corn.
- Approximately 90 percent of the industry production is milled in the larger plants.
- Rather limited volumes of wastewater are generated by plants and, consequently, the estimated costs for waste treatment are not excessive relative to other milling investments and costs.
- Most (if not all) dry corn mills with process wastewaters are said to discharge into municipal treatment systems (a complete inventory is not available), and thus the proposed guidelines will directly impact only a relatively small portion of the industry.
- No known separate treatment systems exist.

The main concern of this impact analysis is directed toward a relatively few of the larger corn dry milling operations which are believed to discharge into surface waters. As is later shown, the expected impacts are not severe for the model plant cases studied. Thus, while specific plants that discharge directly and their locations have not been pinpointed, such additional information is not expected to alter the conclusions reached.

Price effects. Based upon individual model plant analysis for both a medium plant (15,000 bu/day) and a moderately large plant (30,000 bu/day) in the corn dry milling industry, it is estimated that prices of milled products would have to increase from about .6 to 1.1% to recover the estimated costs of pollution control. The upper value was based on the impact to the medium sized plant.

In that only relatively few firms are estimated to be impacted, it is not likely that prices in the industry as a whole will be increased. The impacted firms, operating in a competitive industry, will not be able to pass-through the additional costs for pollution control.

Financial effects. The profitability of the plants impacted will be lower due to pollution control costs, but the impact as indicated in terms of net profit as a percent of sales is not substantial. As shown in Table VII-4, the medium plant had a decline of .4% in net profit on sales (from 1.6 to 1.2%) at the target rate [1/], and the larger plant had a decline of .3% (from 2.6 to 2.3%).

A further indication that the impacts are not expected to be overly severe is the stability of the overall impacts within a ± 30 percent range in the estimated pollution control costs (as are also presented in Table VII-4). Both the BPT and BAT cases were assessed in relation to the base case without pollution controls.

It is noted that the 15,000 bu/day plant had a relatively low net profit on sales value in the base case, yet the estimated pollution control costs did not result in an unprofitable situation. Neither model plant was shown to become unprofitable, and although faced with declining profitability, it does not appear that the types of plants which might be impacted would likely close solely as a result of pollution control impacts.

Additional financial measures of the corn dry milling model plants both with and without pollution controls are presented in Table VII-5. The measures shown were developed as shown for the base case in Chapter II. For the BAT (1983) treatment cases, the after-tax ROI

[1/] Estimated pollution control costs were provided only for the 30,000 bu/day model plant. DPRA estimated that the 15,000 bu/day plant would incur costs equal to .75 times the costs given.

Table VII-4. Net profit as a percent of sales in the corn dry milling industry with and without pollution controls

Size and Cost [1]	Level of Pollution Control		
	None	BPT	BAT
15,000 bu/day			
Target cost plus 30%		1.2	1.0
Target pollution cost [2]	1.6	1.3	1.2
Target cost less 30%		1.4	1.3
30,000 bu/day			
Target cost plus 30%		2.3	2.2
Target pollution cost	2.6	2.4	2.3
Target cost less 30%		2.4	2.4

[1] No provision made for cost recovery by sale of recovered wastes.

[2] Target pollution costs estimated by EPA for the 30,000 bu/day plant. Other data estimated by DPRA.

Table VII-5. Estimated pre-tax net income and rates of return on average invested capital in the corn dry milling industry with and without pollution controls

Size and Level of Pollution Control	Pre-tax net income			Pre-tax ROI			After-tax ROI		
	T+30%	T [1/]	T-30%	T+30%	T	T-30%	T+30%	T	T-30%
	- - - - -	($000)	- - - - - - -	- - - - - -	-(%)	- - - - - -	- - - - - -	-(%)	- - - - - -
Without Pollution Control									
15,000 bu/day		265			10.3			5.3	
30,000 bu/day		843			17.0			8.8	
With BPT Control									
15,000 bu/day	200	215	230	7.3	8.0	8.7	3.8	4.2	4.5
30,000 bu/day	755	776	796	14.6	15.2	15.7	7.6	7.9	8.2
With BAT Control									
15,000 bu/day	170	192	214	6.2	7.1	8.0	3.2	3.7	4.2
30,000 bu/day	741	764	788	14.3	14.9	15.5	7.4	7.7	8.1

[1/] T = Target pollution cost as estimated by EPA for the 30,000 bu/day plant. Other data estimated by DPRA.

dropped from 5.3 to 3.7% for the 15,000 bu/day mill, and from 8.8 to 7.7% for the 30,000 bu/day mill. The smaller plant is impacted more severely, but again neither model plant situation would indicate that plant closures are expected.

A final type of financial analysis completed is a "shutdown" analysis based on calculation of a plant's Net Present Value (NPV) of projected costs and revenues. With this measure it is possible to assess the likelihood of continued plant operation versus closure. Under the assumptions explained below, a positive NPV indicates that a plant (given sunk investments) will probably continue to operate rather than shutdown. The calculation of NPV is based upon the following assumptions for the corn dry milling plants studied:

1. Existing plants have sunk investments but presumably they could be scrapped or salvaged and the salvage value re-invested elsewhere if the corn dry milling function were discontinued. It is estimated that the larger mill (30,000 bu/day), which is comprised largely of buildings and elevators that could be used for other milling functions, would have a salvage value equal to 50 percent of the replacement cost. However, the smaller mill (15,000 bu/day) is estimated to have only a 30 percent recovery value because the smaller facilities would be less attractive for alternative uses.

2. Revenues and expenses are assumed to remain constant over time, i.e., 20 years of operation.

3. The estimated cost of capital, used in calculating the NPV, for the industry is 7.5 percent.

The Net Present Values for the model plants, both with and without pollution controls -- and with a ± 30 percent change in the target pollution control costs, are presented in Table VII-6. In all the situations studied, the NPV's were positive and significantly above zero. This indicates that existing plants are not likely to shutdown due solely to the imposition of pollution controls.

The estimated pollution control costs for the corn dry milling are substantial but not excessive. Consequently, capital availability for pollution control in the corn dry milling industry would not appear to be a major problem. The profitability of plant operations is not expected to be severely impacted and external sources of capital should generally remain available.

Table VII-6. Net present values of corn dry milling model plant cash flows with and without pollution controls [1]

Level of Pollution Control and Cost	Net Present Values of Cash Flows by Plant Size: 15,000 bu/day ($000)	Net Present Values of Cash Flows by Plant Size: 30,000 bu/day ($000)
Without Pollution Control	993.7	2,825
With BPT Control		
Target cost + 30%	416.1	2,054
Target pollution cost [2]	549.4	2,231.9
Target cost - 30%	682.7	2,409.8
With BAT Control		
Target cost + 30%	361.5	1,981.2
Target pollution cost	507.4	2,175.9
Target cost - 30%	653.3	2,370.6

[1] Assuming 20 year operating cash flow at 7.5% cost of capital and a salvage value of 50% of original value of investment for the larger mill and 30% for the smaller mill.

[2] Target pollution cost as estimated by EPA for the 30,000 bu/day plant. Other data estimated by DPRA.

Production effects. No curtailment in production is projected for the corn dry milling as a whole due to pollution controls. No plant closings are expected.

Very few firms are potentially affected by the direct discharge effluent limitation guidelines and these firms are not expected to close. However, even if a small number of plants were to close, there is excess capacity for production in the industry. Industry-wide production should not be curtailed regardless of the impact of the proposed direct discharge guidelines.

The volume of corn processed by the corn dry milling industry has remained rather stable since 1967, ranging from only 114 to 119 million bushels per year from 1967 through 1972. These levels of production have been milled by a steadily declining number of plants, e.g., 152 in 1965 and 124 in 1971. In light of the rather static demand situation for corn dry milling products and the general excess milling capacity, the "trends" of industry growth should not be affected by the imposition of the pollution controls indicated in this study.

The NSPS, new source performance standards, would have the same relative effects on new plants as the indicated BAT effects above. As such, these effects would present only a limited deterrent to entry. The pollution control investment costs represent about 5 percent of the original investment costs. This incremental investment requirement should not prohibit entry if a new plant is otherwise sufficiently viable.

Employment effects. Employment losses are not expected because neither production curtailment nor plant closings are projected due to the pollution controls involved. Increased production costs resulting from pollution controls, without expected price increases to offset these costs, may induce other inplant changes to improve plant performance. Such changes cannot be predicted, however, an offsetting factor would be the need for additional labor for operating the treatment system. On balance, no change in employment is projected.

Community effects. With no plant closures or production curtailments expected in the corn dry milling industry, no significant community effects are projected.

Other effects. No balance of trade or other detrimental direct effects are forseen as a result of the imposition of the proposed effluent limitation guidelines on the corn dry milling industry. The direct effects of the pollution controls should not result in major disruptions in markets served by this industry.

Power and energy needs are estimated to increase only by a small increment relative to existing requirements; therefore, no problems due to excessive increases in the demand for power and energy are expected.

Bulgur Processing

The bulgur industry has a variety of characteristics which, in summary, preclude its having detrimental economic impacts from the pollution controls proposed in this study. In brief, key characteristics of the bulgur industry affecting this analysis are as follows:

- Only 6 plants currently commercially produce bulgur in the U.S. Total production is relatively minor in comparison with other milling industries.
- Only small volumes of wastewater are generated and this flow contains moderate wasteloads.
- All existing plants are reported to discharge into municipal systems for treatment. No independent treatment systems exist and none are expected to be required.
- The proposed treatment practices, if required, are relatively inexpensive to construct and operate.

In effect, the proposed BPT and BAT standards will not apply to any existing plants in the bulgur industry. Consequently, there is no expected economic impact from the direct discharge pollution control guidelines in this industry.

In terms of the various effects to be evaluated it is concluded:

Type of Effect	Expected Impact
Prices	No change
Financial	Controls not applicable
Production	No change
Employment	No change
Community	None
Other	None

The proposed NSPS standards (new source treatment) could, however, provide a deterrent to entry into the bulgur industry. As a basis for judging the potential impact of the NSPS standards, it is possible to utilize the model plant data generated for bulgur industry.

Assuming that the NSPS impacts would equal the BAT impacts as previously defined, then it is convenient to repeat the type of model plant analysis shown above where the BAT and NSPS effects are considered equal. Only one model plant -- a medium sized, 5,000 cwt/day plant, is evaluated as representative of the industry.

In terms of price effects, it was estimated that prices would have to increase only by about .5% to cover the estimated BAT pollution control costs. Hence the proposed treatment requirements would not seriously affect plant operations.

The level of profitability would also be affected only slightly as shown in Table VII-7, where net profit on sales declined from 1.7 to 1.5% at the target pollution control cost level. Change in control costs of ± 30 percent resulted in less than .1% additional change in net profit on sales. This rather tight pattern indicates rather modest impacts within the range of costs considered. If a new plant were considered viable prior to pollution controls, then the proposed control costs would not likely be a deterrent to entry.

Some additional financial measures are indicated in Table VII-8 for the medium-sized bulgur plant. In this case, for example, the estimated after-tax ROI is estimated to decline from 7.0 to 6.0% at the target rate. A .3% additional change is indicated for either a ± 30 change in estimated pollution control costs. Again, these data suggest that pollution control cost impacts on the bulgur industry are not severe.

The Net Present Value calculations for the shutdown analysis are not strictly applicable for a new source situation. However, these calculations were made as if an existing plant were required to treat its wastes. Relatively large positive NPV's were obtained at a cost of capital discount rate of 7.5%. This is a further indication that the proposed controls should not cause economic dislocations in the bulgur industry.

In summary, the proposed pollution control costs are not a serious deterrent to potential new source bulgur processors. Also, even if existing plants were required to provide their own treatment systems, the estimated impacts would be nominal.

Table VII-7. Net profit as a percent of sales in the bulgur processing industry with and without pollution

Size and Cost [1]	Level of Pollution Control	
	None	NSPS [3]
Medium Bulgur Plant		
Target cost plus 30%		1.4
Target pollution cost [2]	1.7	1.5
Target cost less 30%		1.5

[1] No provision made for cost recovery by sale of recovered wastes.

[2] Target pollution cost as estimated by EPA.

[3] The NSPS (New Source) pollution control requirements are assumed equal to the BAT (1983) requirements as provided.

Table VII-8. Estimated pre-tax net income and rates of return on average invested capital in the bulgur processing industry with and without pollution controls

Size and Level of Pollution Control	Pre-tax net income			Pre-tax ROI			After-tax ROI		
	T+30%	T [1/]	T-30%	T+30%	T	T-30%	T+30%	T	T-30%
	- - - - -	($000)	- - - - - -	- - - - -	(%)	- - - - - -	- - - - -	(%)	- - - - - -
Without Pollution Control									
Medium bulgur plant		171			12.6			7.0	
With NSPS Control [2/]									
Medium bulgur plant	143	150	156	10.1	10.6	11.2	5.7	6.0	6.3

[1/] T = Target pollution cost as estimated by EPA.

[2/] The NSPS (New Source) pollution control requirements are assumed equal to the BAT (1983) requirements as provided.

Parboiled Rice Milling

Parboiled rice milling is also a rather small segment of the overall grain milling industry; but it is an economically important industry and a concern exists regarding the potential impacts of water pollution controls. However, as indicated briefly below, some key factors regarding the industry indicate that the proposed direct discharge pollution controls will not directly affect this industry:

- Only 6 of 42 rice mills in the U.S. currently produce parboiled rice.
- Moderate wasteflows are generated and they are amenable to biological treatment.
- All existing parboiled rice mills discharge wastes into municipal treatment systems (regular mills have no process wastewaters).
- No independent waste treatment systems are expected to be required in the industry.

Because of waste discharges into municipal systems, the parboiled rice mills will not be affected by the proposed BPT and BAT standards of this study. Consequently, there is no expected economic impact from the direct discharge pollution control guidelines on this industry.

Regarding each of the various effects for which an impact assessment is desired, the following brief conclusions are made:

Type of Effect	Expected Impact
Prices	No effect
Financial	Controls not applicable
Production	No change
Employment	No change
Community	No effect
Other	None

A related concern, however, is the potential impact of the proposed NSPS standards (new source treatment) which could affect the entry of new firms into the parboiled rice milling industry. By utilizing the model plant data generated for this study, the potential impact of the NSPS standards can be judged.

In this case it is assumed that the NSPS guidelines and control costs are equal to the BAT data provided. Further, the impacts are expected to be equal for purposes of this analysis and the type of model plant analysis used above is repeated to assess the NSPS impacts. A moderately large (8,000 cwt/day) mill is evaluated as a prepresentative mill in the industry.

It is estimated that the model plant would require a price increase of about .8% on its final products if it were to fully recover the estimated NSPS costs of pollution control. Since existing plants would not have comparable incremental costs, it is not expected that a new plant could pass-through such costs. Thus, the profitability of a new source plant would be reduced relatively.

As shown in Table VII-9, net profits as a percent of sales would be reduced by about .2%, or a decline from 1.6 to 1.38% as shown for the model plant. A new plant may have different financial characteristics than estimated herein; however, the relative impacts should be comparable to that shown. The net profit on sales ratio did not change substantially within a ± 30 percent variance in the estimated pollution control cost target. This reaffirms the idea that the effects on profitability would be approximately as shown within a reasonable range of the target costs used.

Additional financial measures, as shown in Table VII-10, are further indication of the generally limited impact of estimated pollution control costs on the profitability of the model plant. The after-tax ROI as reported is shown to decrease from 11.7 to 10.7% for the target level case, or by 1.0%. This general level of impact would probably not deter a new plant from entry into the industry if it were otherwise economically viable.

The above data suggest that an existing mill, if it had to provide wastewater treatment, would probably do so. Although not strictly applicable for the new source NSPS case, it is also noted that the Net Present Values for existing plants as calculated for the shutdown analysis (discussed above) were positive and relatively large for this industry. This further supports the belief that the proposed controls should not cause serious economic dislocations in the parboiled rice milling industry.

In conclusion, the proposed pollution control costs are not believed to be a major deterrent to potential new source parboiled rice milling operations. Further, in the event that an existing plant were required to provide its own treatment system, the estimated impacts would be marginal. Based on a representative model plant case, existing plants would not be expected to close given the target pollution control costs.

Table VII-9. Net profit as a percent of sales in the parboiled rice milling industry with and without pollution controls

Size and Cost [1]	Level of Pollution Control None	 NSPS [2]
Moderately Large Parboiled Rice Plant		
Target cost plus 30%		1.25
Target pollution cost [3]	1.6	1.38
Target cost less 30%		1.42

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[1] No provision made for cost recovery by sale of recovered wastes.

[2] The NSPS (New Source) pollution control requirements are assumed equal to the BAT (1983) requirements as provided.

[3] Target pollution cost as estimated by EPA.

Table VII-10. **Estimated pre-tax net income and rates of return on average invested capital in the parboiled rice milling industry with and without pollution controls**

Size and Level of Pollution Control	Pre-tax net income			Pre-tax ROI			After-tax ROI		
	T+30%	T 1/	T-30%	T+30%	T	T-30%	T+30%	T	T-30%
	------	($000)	------	------	(%)	------	------	(%)	------
Without Pollution Control									
Moderately large parboiled rice plant		463			11.6			11.7	
With NSPS Control 2/									
Moderately large parboiled rice plant	404	379	354	8.4	9.1	9.8	10.2	10.7	10.9

1/ **Target pollution cost as estimated by EPA.**

2/ The NSPS (New Source) pollution control requirements are assumed equal to the BAT (1983) requirements as provided.

VIII. LIMITS OF THE ANALYSIS

The foregoing impact analysis was based upon data and information from industry sources, from published secondary data sources, and from subjective judgment. At various stages, the data utilized are subject to error.

The nature and scope of possible errors should be identified and limits placed on the analysis accordingly. The purpose of this final section is to present limits of the analysis in terms of accuracy, range of error, critical assumptions and questions remaining to be answered.

General Accuracy

Financial information concerned with investments, operating costs and revenues was in general not available for individual plants or firms in the grain milling industry. Consequently, the financial aspects of the impact analysis were, of necessity, based upon synthesized costs and returns for "representative" model plants within each subindustry studied. The accuracy of the financial data used is difficult to measure, however it is believed that the data used are representative. Various checks were made to establish the reasonableness of the data used.

The requisite data were developed by DPRA from a variety of sources including published materials from universities and government agencies, previous studies done by DPRA, information obtained from industry sources including trade associations, published financial performance data sources, and from private individuals knowledgeable of the industry. A variety of crosschecks were made using published information from the Internal Revenue Service, Standard and Poors, Dun and Bradstreet and other financial data sources to ascertain whether the simulated performance of the model plants were representative of the financial performance experienced in the respective grain milling subindustries. Based on these crosschecks, it is believed that the model plants are representative and suitable for assessing the incremental impacts of pollution controls.

It is noted that in the recent past the grain commodity markets in general (including corn, wheat and rice) have been exceptionally volatile and record high prices have been established. These prices directly affect the grain milling industry and the full repercussions on the milling industry are not yet known. Therefore, in order to best reflect normal milling conditions, DPRA elected to base gross margin estimates on 1967-1971 average price conditions. While this procedure does not accurately represent current prices, it was felt that average gross margins would better reflect expected conditions in the industry.

Water pollution control costs were provided by EPA (and Sverdrup & Parcel and Associates). These data were developed for a typical plant within each subindustry studied. It was necessary to adapt these data in some cases for alternative sized plants. DPRA adjusted or scaled these data as described above to reflect the general type of change required, but there may be considerable inaccuracy involved.

Another concern involving the water pollution control costs is that no costs were provided or assumed for in-plant modifications which may also be required to achieve the effluent guidelines. As a partial compensation for this potential cost, the control costs given were varied by ± 30 percent. The higher level could serve as a surrogate for associated in-plant modifications.

Range of Error

Different data series and different portions of the analysis will have various possible ranges of error. Subjective estimates of error ranges for the grain milling industry as a whole (or subindustries if indicated) are as follows:

	Error Range
1. Number, location, size or other organization and structure information	
a. Corn wet milling	-
b. Corn dry milling	±10 %
c. Bulgur	-
d. Parboiled rice milling	-
2. Price information for products and raw materials	± 5 %

3.	Cost information for plant investments and operating costs	±10 %
4.	Financial performance information	±10 %
5.	Salvage values of plants and equipment	±20 %
6.	Water pollution control costs	Unknown

Critical Assumptions

In order to complete this analysis of the grain milling industry within the scope of study established, a variety of assumptions were required. Some critical assumptions were applicable to all segments studied, while others were specific to a given subindustry. The main assumptions deserving further comment are described below.

Representativeness of Model Plants. It is difficult to represent an industry or subindustry with only 1 to 3 model plant situations when there are actually many sizes and types of plants in the industry. In the four subindustries studied, the most difficult one to represent simply was corn wet milling. No two plants in this industry are alike because numerous end-products and product mixes can be produced.

The corn wet milling model plants were assumed to produce an overall industry "average" mix of products. This approach seemed reasonable within the limits of this study, but additional cases would be required to simulate various actual operations.

The other subindustries are less subject to wide variation although product mixes can differ from the assumed conditions, especially in corn dry milling.

Model Plant Cost Data. Secondary or published investment and operating cost data are minimal in the grain milling industry. Engineering synthesis techniques had to be relied upon as a basis for constructing most of the model plant cost data. Piecemeal published data and information provided by knowledgeable industry sources were correlated with the engineering data. The resulting model plant data were believed reasonable and representative, but the data are not based on reported "book value" statistics.

Prices and Inflation. Current prices in the grain milling industry are presently distorted and not believed representative of future expectations. Prices and margins used un the model plant cases are typically 1967-1971 averages. This price data was assumed to better represent the grain milling industry.

It is commonly assumed that both costs and returns will be proportionately affected by inflation impacts; however, it is noted that pollution control costs are increasing relatively faster than other segments of the economy. One might question the accuracy of the estimated 1977 and 1983 waste treatment costs relative to other costs and prices.

Status of Current Effluent Controls. Within the corn dry milling subindustry it is assumed that only "very few" of the plants currently discharge into surface waters and that these mills are large plants. Further verification of this assumption is needed. Contacts with industry association sources indicated that no plant-by-plant survey had been completed, although the general statements used in this report were verified.

Salvage Values. The alternative salvage values presented for the shutdown analysis above are subject to wide variation based on plant location, size, prospective alternative uses, etc. The smaller model plants, if higher salvage values were possible, would more likely shutdown since profits were generally low (although not negative) for these cases.

Water Pollution Controls. In assessing the impacts of the water pollution control costs provided, no allowance was assumed for in-plant modification costs. Further assessment of this source of costs may be warranted. As previously noted, a ± 30 percent change in pollution control costs was analyzed to indicate sensitivity of financial measures to the estimated costs.

Most of these and other less critical assumptions have been discussed previously in this report. Such assumptions are based upon best judgments given prevailing conditions in the grain milling industry.

Remaining Questions

One of the main questions remaining concerns a more precise knowledge of the number, size and location of corn dry milling plants which discharge directly into surface waters. Smaller plants would be adversely affected and might close. This should have little effect on the industry as a whole, however.

The availability of land for installing the type of waste treatment facilities proposed is also a remaining question. Since the corn wet millers have or are building waste treatment systems, they have some additional land, but is it adequate for additional treatment requirements, e.g., deep bed filtration? Land availability by any affected corn dry millers is also of concern.

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5.3

16. Abstracts (continued)

Corn wet mills have the most serious effluent problems. However, only 5 of 17 plants discharge directly into surface waters. These plants will be impacted severely relative to the remainder of the industry, but none are expected to shut down.

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